INDUSTRIAL
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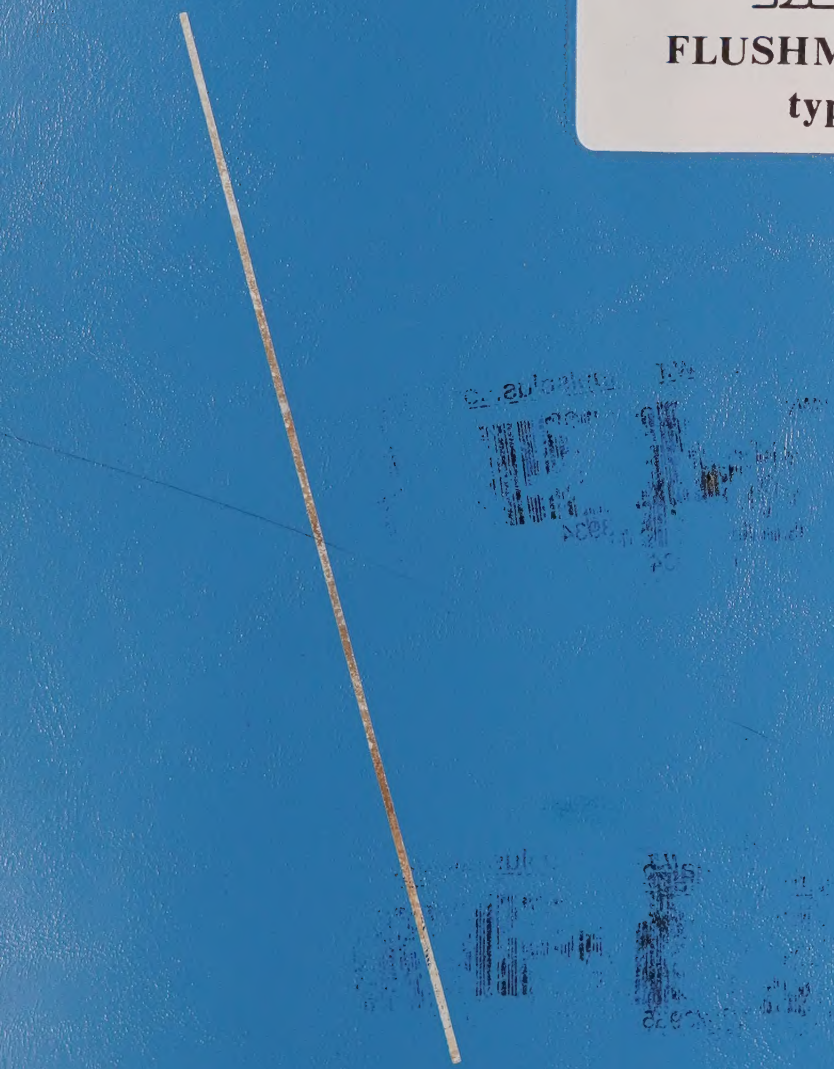
DIVISION

servo/riter® II
FLUSHMOUNT RECORDERS
type B electronics



TEXAS INSTRUMENTS
INCORPORATED
HOUSTON, TEXAS

servo/riter® II
FLUSHMOUNT RECORDERS
type B electronics

OPERATING INSTRUCTIONS MANUAL
PART NO. 185000-0000A

INDUSTRIAL
PRODUCTS
DIVISION

TEXAS INSTRUMENTS
INCORPORATED

P.O. BOX 66027 HOUSTON, TEXAS 77006
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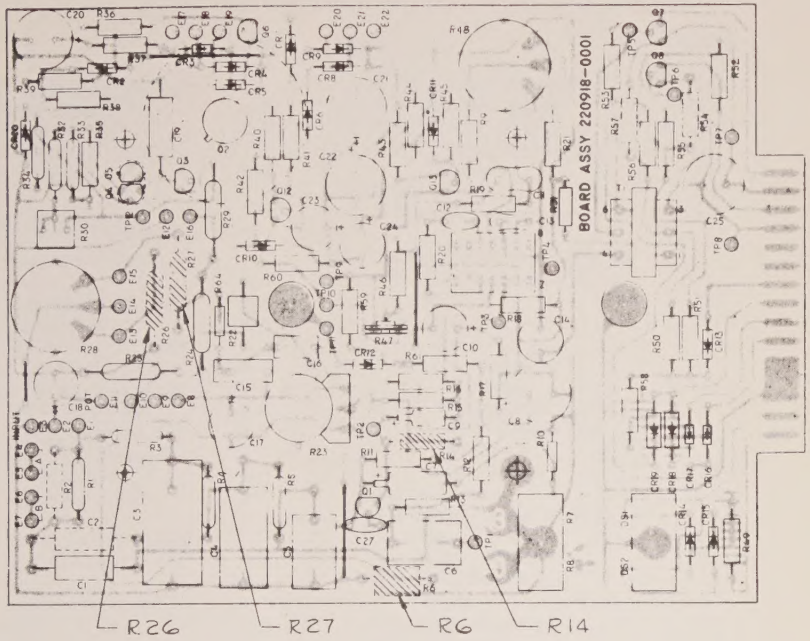
LTR	DESCRIPTION	DATE	APPD



INSTRUCTIONS FOR CHANGING RANGE ON THE B2 ELECTRONICS BOARD

THERE ARE TWO RESISTORS INVOLVED IN CHANGING THE SPAN OF THE RECORDER. THESE HAVE THE REFERENCE DESIGNATORS R6, R14. R6 IS THE RESISTOR WHICH DETERMINES THE SPAN. THIS IS A WIREWOUND RESISTOR 1/4 OD X 375 LONG. R14 PROVIDES A COARSE GAIN SETTING FOR THE AMPLIFIER. IT IS 1/2W CARBON COMPOSITION RESISTOR .140 OD X .375 LONG.

R26 AND R27 ARE 3W±1% WIREWOUND RESISTORS WHICH CONTROL THE ZERO POSITION. THE ZERO POSITION IS SPECIFIED IN PERCENT OF SCALE FROM THE LEFT MARGIN.

THE LOCATIONS OF THESE FOUR RESISTORS ON THE PRINTED CIRCUIT BOARD ARE CLEARLY INDICATED ON THE ILLUSTRATION.

SEE ALSO FIGURE 3-5 OF THE MANUAL FOR STANDARD ZERO AND SPAN VALUES.

CHANNEL	RESISTOR VALUE IN OHMS (NOTE)					
	SPAN	R6	R14	ZERO	R26	R27
A	1 MV	385.2	43K	FULL		
B	1MV	385.2	43K	FULL		
C						
D						
E						
F						

NOTE: FILL IN ABOVE TABLE WITH THE PROPER VALUES FOR THE DASH NUMBER OF THE NEXT ASSEMBLY AS SPECIFIED BY THE SALES ORDER.

-0002	-0001	ITEM NO.	UNIT OF ISSUE	DWG SIZE	PART NUMBER	DESCRIPTION	VENDOR PART NUMBER
QTY REQD		LIST OF MATERIALS					

UNLESS OTHERWISE SPECIFIED

DECIMAL .XX ± .02 .XXX ± .010
FRACTIONAL ± 1/64 ANGULAR ± 1°
CONCENTRICITY MACHINED DIAMETERS .004 TIR
ALL DIMENSIONS TO BE MET BEFORE PLATING
REMOVE ALL BURRS AND SHARP EDGES
DO NOT SCALE THIS DRAWING
ALL DIMENSIONS IN INCHES
SURFACES MARKED ✓ TO HAVE ✓

DRILLED HOLE TOLERANCES
.013 TO .136 .003 .002 — .136 TO .250 .005 .003
.250 AND ABOVE ± .005

PROCESSES

PROJ NO.	SIZE	NEXT ASSY DWG NO.
3573-3781	A	220920 (ALL)
3578-3780	A	220921 (ALL)

DRAFTSMAN 5-1-69 J. Slagel
CKD—DRAFTSMAN
DESIGN ENGINEER 5-8-69 Ed Kegley to Moody
APPD—ENGINEER 5/31/69 W A Ebbers
APPD—MFG
RELEASE 5/12/69 J. Williamson

TEXAS INSTRUMENTS
INCORPORATED
INDUSTRIAL PRODUCTS DIVISION
HOUSTON, TEXAS

TITLE INSTRUCTIONS, RES. PLACEMENT & RANGE
UNIT AMPLIFIER, MODEL B2
SYSTEM SERVO-RITER II
SCALE 1/1 B 220932 REV.

TI-9641-B

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SECTION I
GENERAL DESCRIPTION

1-1 SCOPE OF MANUAL.

This manual contains operating instructions for the servo/riter® II Potentiometric Recorders using Type B electronics (Intermediate Sensitivity Amplifier) manufactured by Texas Instruments Incorporated, Houston, Texas.

Texas Instruments supplies recording instruments designed to customer requirements and it would be impractical to issue a manual custom-designed to each instrument. This instruction manual covers standard equipment, and blueline drawings further describe a recorder where circuit or major assembly changes have been made to meet specific customer requirements. Table 1-1 provides the serial number and information on the recorder this particular manual describes.

The servo/riter® recorder is a self-balancing potentiometric strip chart recorder, for accurate recording of dc signals. The signal input leads are floating above ground and the circuit makes use of a guard shield to accurately record signals that have ac and dc common-mode interference. The recorder uses a low-pass input filter to provide transverse interference rejection.

TABLE 1-1

RECORDER DESCRIBED BY THIS MANUAL

MODEL FS02N6B SERIAL NO. 9160-2

1. CHANNEL	A	B	C	D	E	F
Span	1mv	1mv				
Speed-Seconds	1sec	1sec				
Attenuator	11step	11step				
Zero	FSZ	FSZ				
Pen Lifter	N/A	N/A				
Control Contacts	N/A	N/A				
Retransmit Potentiometer	N/A	N/A				

2. CHART DRIVE BE - 1.5- 3- 6- 12- 24=IPH

3. ACCESSORIES

Left Marker	☐	Lighting	☐
Right Marker	☐	Tilt Out Platen	☐
Door ☑ Lock	☐	Chart Supply Indicator	☐

4. POWER 120 V 60 Hz

5. SPECIAL PRODUCT DRAWING NO. 358

The electronics is solid state, including a photoconductive chopper. A zener reference unit is standard on all servo/riter® II recorders. The portable model is available in one or two channels. The flushmount recorder is designed to fit a standard 19-inch rack without special adapters and is available in one to six channels with many options and accessories. These are listed in the servo/riter® brochure.

Primary applications occur with manufacturers of instruments or end users which require a dc recorder readout either built-in or as a separate accessory. Such instruments, used for research laboratory, engineering test, clinical operations and industrial processes, include the following typical examples:

Gas chromatographs
UV and IR spectrophotometers
Radiation control meter
Mass spectrometers
Respiration analyzers
X-ray spectrometers and diffractometers
Electrobalances
Precision voltmeters
Line and frequency standards
Polaragraphs
Polarimeters
Cardiac densitometers
Environmental test stands
Performance test stands
Life test stands
Received signal and noise level
Magnetic intensity meters
Meteorological instruments

1-2 SPECIFICATIONS.

The electrical specifications are listed in Table 1-2.

1-3 SUMMARY OF STARTUP PROCEDURE.

Placing the servo/riter® II into operation requires these simple steps.

a. Physical mounting of recorder (Paragraph 2-1)
b. Connecting power (Paragraph 2-2.2)
c. Applying signals (Paragraph 2-2.3)
d. Installing chart paper (Paragraph 3-1)
e. Filling and priming inkwells (Paragraph 3-2)
f. Using operational controls (Paragraph 3-4)

TABLE 1-2

ELECTRICAL SPECIFICATIONS

Item	Description
Line voltage	120V ± 10% at 60 Hz (50 Hz available for B2 and B3)
Deadband	<0.15% for recorders with 0.4 or 0.5 sec span step response
	<0.1% for recorders with 1 sec or more span step response
Accuracy	±0.25% or ±5μV
Linearity	<0.1%
Off-balance impedance	150,000 ohms for B1
	80,000 ohms for B2 or B3

TABLE 1-2 (Continued)

ELECTRICAL SPECIFICATIONS

Item	Description
Span	Standard available: 2, 5, 10, 50, 100 mV for B1 1, 5, 10, 50, 100 mV for B2 Numerous thermocouple spans from 1 mV minimum for B3
Zero position	From -100% to +200% on B1 or B2 Up to 12:1 suppression or elevation on B3
Input circuit	Floating and guarded
Guard to ground voltage rating	500 V maximum
Interference rejection	Over 60 DB transverse at 60 Hz Over 100 DB ac common mode at 60 Hz Over 100 DB dc common mode with 25,000 ohms in series with minus input lead Over 120 DB dc common mode with less than 1000 ohms resistance between low-side lead and the common-mode voltage
Span step response	NOMINAL SPAN STEP response times of 0.5, 1, 5, 10, or 24 seconds are available. (With B2 and B3 electronics, the actual response time for the fastest speed recorders is approximately 0.41 sec for zero source impedance. With B1 electronics it requires a few hundredths of a second longer because of the settling time of the input filter.)
Frequency response 10% amplitude, zero source resistance	B1 3 DB at 3 Hz B2, B3 3 DB at 4 Hz
10 kilohm source resistance	B1 3 DB at 1.2 Hz B2, B3 3 DB at 2.2 Hz
Source resistance rating	20,000 ohms (This value will slow up the recorder, but cause negligible effect on accuracy.)

SECTION II
INSTALLATION AND PRELIMINARY CHECKOUT

2-1 MOUNTING THE EQUIPMENT.

NOTE

Wide-carriage recorder in this manual refers to either the single 9-3/4-inch wide-grid recorder or the dual 4-1/2-inch grid recorder. Narrow-carriage recorder refers to the 6-inch narrow-grid recorder.

Figure 2-1 shows dimensions for panel mounting of wide- and narrow-carriage recorders. To mount the recorder in a panel mounting surface:

a. Place recorder on floor or bench to provide support under the chassis when it is pulled out.
b. Open the back panel and lay it back on its hinge.
c. Lift up on the chassis latch handle and pull out the chassis until it stops.
d. Lift up the back panel and rotate 90°. Place it inside the case in back of chassis.
e. Release the slide stops. Pull out the chassis and attached back panel through the front of the case. The empty case may now easily be placed in a rack or panel and attached with eight 10-32 x 3/8-inch binding-head screws.
f. After the case is secured, reverse the preceding instructions to install the chassis. Check that the interconnecting cable remains clear of the chassis as the chassis is slid back into the case.

The recorder is now ready for power connection.

2-2 EXTERNAL CONNECTIONS.

All external connections are made inside the rear panel as shown in Figure 2-2. Working access to these connections is convenient from rear of the recorder case.

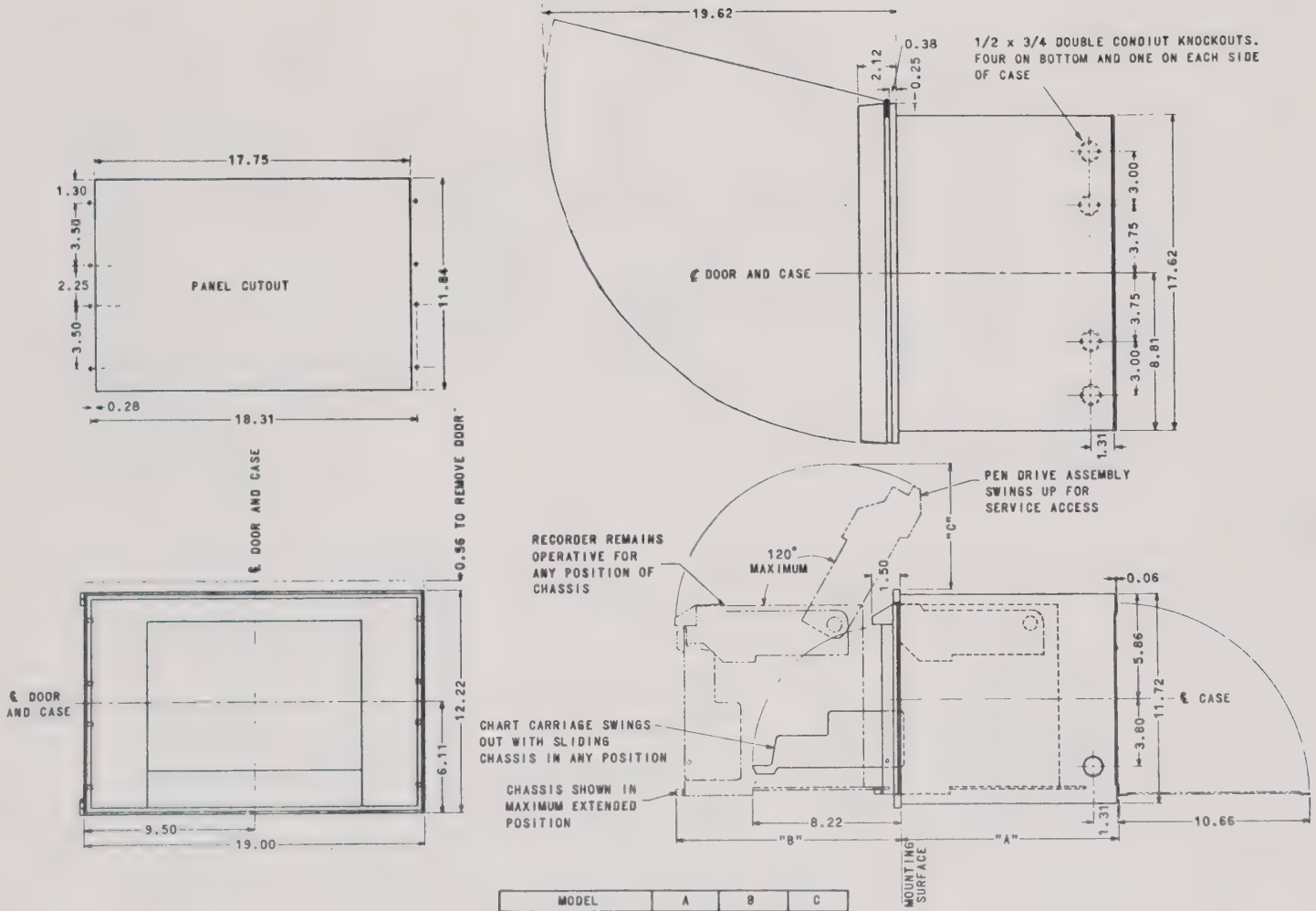
2-2.1 REAR ACCESS. For rear access remove the four screws holding the rear panel in place and pivot the panel about its bottom edge. The catch at the bottom edge of the panel holds the rear panel in a horizontal position to form a shelf.

2-2.2 POWER CONNECTIONS. Figure 2-2 shows the power and accessory terminal board provided inside the rear panel. Figure 2-3 shows power and accessory wiring terminal connections. Three terminals are provided for the power connections: L1 and L2 for power, and GND for ground connection. Knockout plugs are provided for 1/2-inch and 3/4-inch conduit or for a clamping bushing if a standard line cord is to be used.

WARNING

A good ground connection is essential for operator safety and for elimination of electrical interference.

2-2.3 INPUT CONNECTIONS. An insulated and shielded cable such as Belden 8771 (TI Part No. 230252-0005) or equivalent is recommended for recorder connections. If this type of cable is not available, twist the signal (positive and negative) leads for best results. The leads should be kept as short as possible to reduce interference and carefully routed to avoid obvious sources of interference such as power lines and magnetic fields.



MODEL	A	B	C
1- AND 2-CHANNEL	12.18	12.50	6.94
3- AND 4-CHANNEL	19.44	17.50	13.44
5- AND 6-CHANNEL	24.00	21.50	18.94

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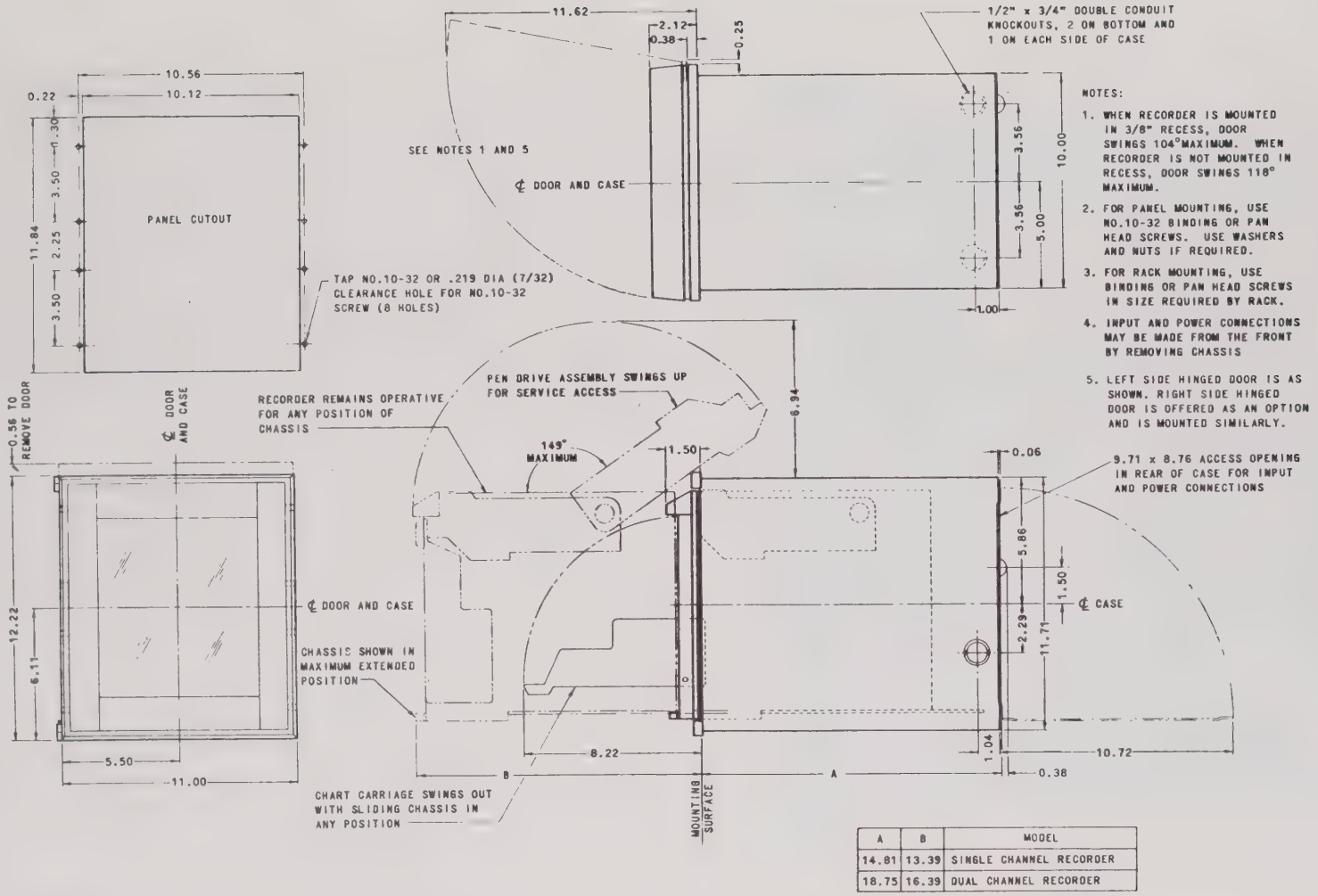
Figure 2-1. Outline and Mounting Dimensions (Sheet 1 of 2: Wide-Carriage Recorder)


11.62
2.12
0.38
0.25
1/2" x 3/4" DOUBLE CONDUIT KNOCKOUTS, 2 ON BOTTOM AND 1 ON EACH SIDE OF CASE
NOTES:
1. WHEN RECORDER IS MOUNTED IN 3/8" RECESS, DOOR SWINGS 104° MAXIMUM. WHEN RECORDER IS NOT MOUNTED IN RECESS, DOOR SWINGS 118° MAXIMUM.
2. FOR PANEL MOUNTING, USE NO.10-32 BINDING OR PAN HEAD SCREWS. USE WASHERS AND NUTS IF REQUIRED.
3. FOR RACK MOUNTING, USE BINDING OR PAN HEAD SCREWS IN SIZE REQUIRED BY RACK.
4. INPUT AND POWER CONNECTIONS MAY BE MADE FROM THE FRONT BY REMOVING CHASSIS
5. LEFT SIDE HINGED DOOR IS AS SHOWN. RIGHT SIDE HINGED DOOR IS OFFERED AS AN OPTION AND IS MOUNTED SIMILARLY.
SEE NOTES 1 AND 5
℄ DOOR AND CASE
10.56
10.12
0.22
1.30
3.50
2.25
3.50
11.84
PANEL CUTOUT
TAP NO.10-32 OR .219 DIA (7/32) CLEARANCE HOLE FOR NO.10-32 SCREW (8 HOLES)
3.56
3.56
5.00
10.00
1.00
0.56 TO REMOVE DOOR
℄ DOOR AND CASE
RECORDER REMAINS OPERATIVE FOR ANY POSITION OF CHASSIS
PEN DRIVE ASSEMBLY SWINGS UP FOR SERVICE ACCESS
149° MAXIMUM
6.94
1.50
0.06
9.71 x 8.76 ACCESS OPENING IN REAR OF CASE FOR INPUT AND POWER CONNECTIONS
5.86
1.50
℄ CASE
2.29
11.71
12.22
6.11
℄ DOOR AND CASE
CHASSIS SHOWN IN MAXIMUM EXTENDED POSITION
5.50
11.00
8.22
1.04
10.72
0.38
B
A
MOUNTING SURFACE
CHART CARRIAGE SWINGS OUT WITH SLIDING CHASSIS IN ANY POSITION

A	B	MODEL
14.81	13.39	SINGLE CHANNEL RECORDER
18.75	16.39	DUAL CHANNEL RECORDER

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3-31-66

Figure 2-1. Outline and Mounting Dimensions (Sheet 2 of 2: Narrow-Carriage Recorder)

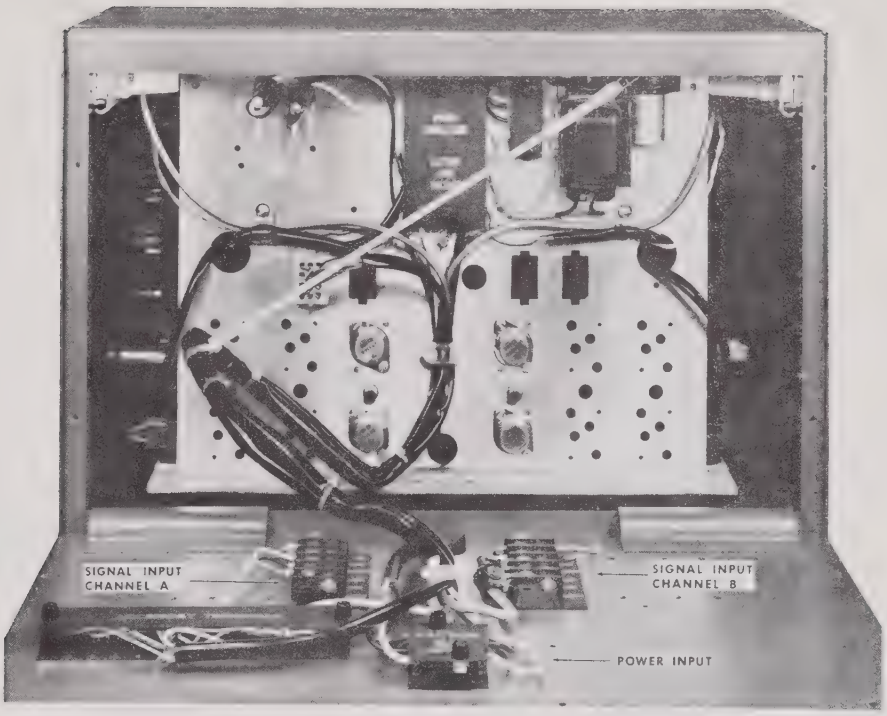


Figure 2-2. External Connections (Two Channel Recorder Shown)

The correct connection depends on the characteristics of the signal source being monitored. For example, whether the source is grounded or floating, the amount of impedance to ground, etc; therefore, some knowledge of the souce is required.

Additional precautions are necessary when operating the recorder with a completely floating input circuit. Such a situation is subject to signal source leakage currents and high common-mode interference. Care should be taken that input connections reject most recorder interference.

The recorder input connections are on a barrier type terminal block on the inside of the rear cover. Terminals are marked INPUT+, INPUT-, GUARD, GND and ATTEN. Recorders with model B1 electronics system should have the GUARD connection connected to INPUT-. (This has the effect of connecting the shield of the cable, which carries the input signal from the back cover over to the input and amplifier board, to INPUT-. On the model B1 input and amplifier board, the GUARD is internally connected to the negative input. There is no connection for the cable shield on the input and amplifier board.)

In B2 and B3 electronics there is a provision for connecting the cable shield on the board. Thus, it does not matter whether or not the INPUT is connected to GUARD. It will normally be connected for consistency.

In a small minority of applications, when the positive side of the signal source has a much lower impedance to a source of common-mode voltage or longitudinal stray than the negative lead, better interference rejection may be obtained by connecting the positive lead to INPUT-. In this case, the recorder will tend to move downscale for an increasing signal magnitude. If it is acceptable to use a right-hand zero, the recorder may be used in this manner. However, if it is desired that the recorder read upscale for an increasing signal and have a left-hand zero, three other changes are required. First, interchange the black

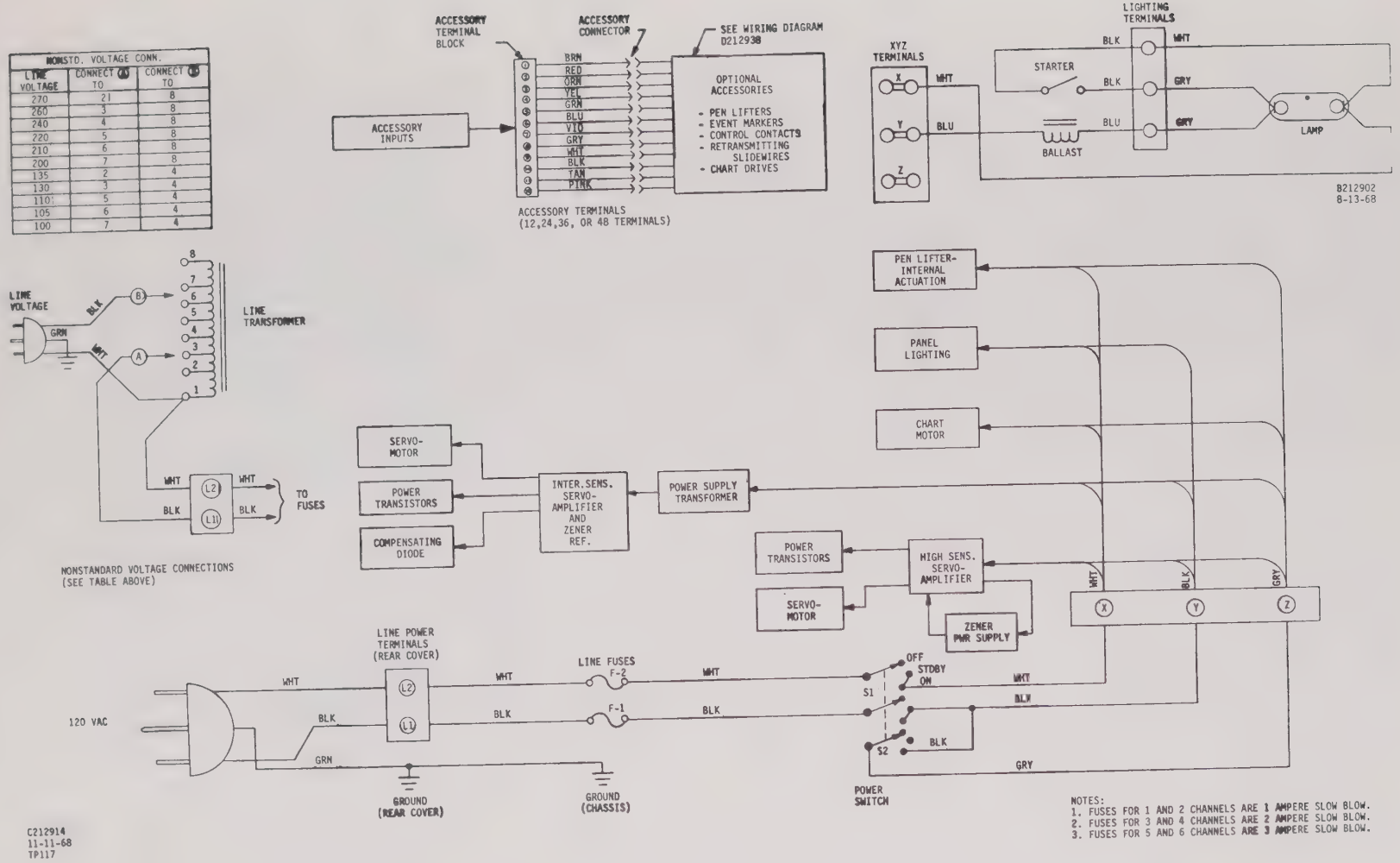


Figure 2-3. Power and Optional Accessory Wiring

and white leads from the feedback potentiometer where they plug into the pins on the amplifier and input board. Second, interchange the position of zero position resistors R26 and R27. Third, interchange connections 1 and 2 in the red motor connector as follows:

a. To interchange the connections, first separate the connectors.
b. Wedge a screwdriver blade (Figure 2-4) between the chassis and edge of the connector and twist to unplug the connector. The metal connection points are held in place by small projecting metal tabs. If the tabs are compressed with a pair of tweezers or a screwdriver is inserted, the metal connections can be pulled out of the back of the connector and interchanged.

For a ground connection, a jumper wire is supplied with both ends connected to the GND terminal. If the signal source is to be grounded at the recorder, one end of the jumper may be moved from GND to GUARD.

Do not ground the GUARD or either of the signal leads at the recorder if the signal source has a ground. Having more than one ground is one of the most common sources of noise in low-level measuring systems. This is especially true when the signal source and the measuring system lack a common ground. However, if the signal source is floating and has no other connection to ground, such as a thermocouple in air, connect the negative input terminal to ground at the recorder.

Figure 2-5 is a schematic showing the various input connections.

2-3 CHECKOUT DESCRIPTION.

2-3.1 POWER SWITCHES. Turn the power switch ON. All power switches have at least two other positions, OFF and STANDBY. In STANDBY there is power to all parts of the recorder except the motors. In the ON position power is supplied to all parts of the recorder including the motors. When the power switch is first turned to STANDBY or ON, it takes about 5 seconds for the

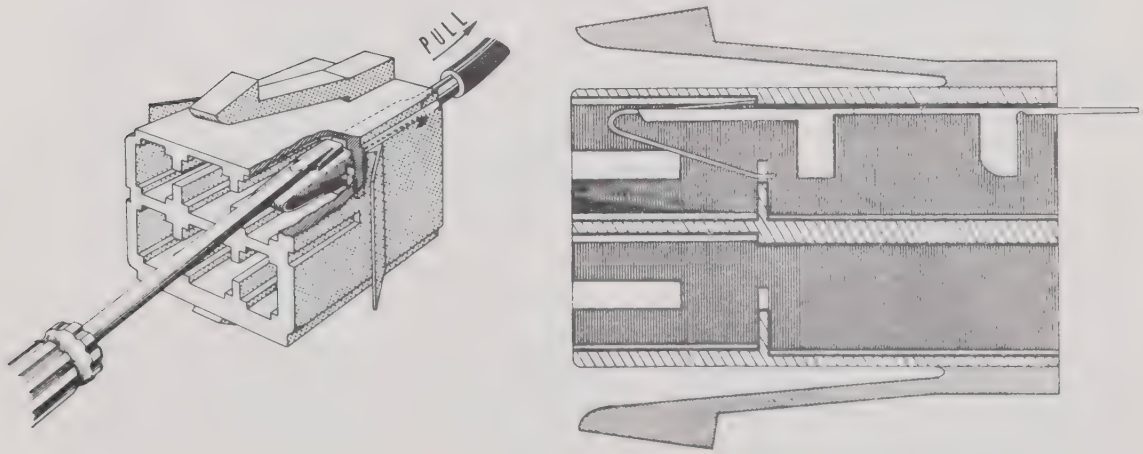


Figure 2-4. Removing Connections

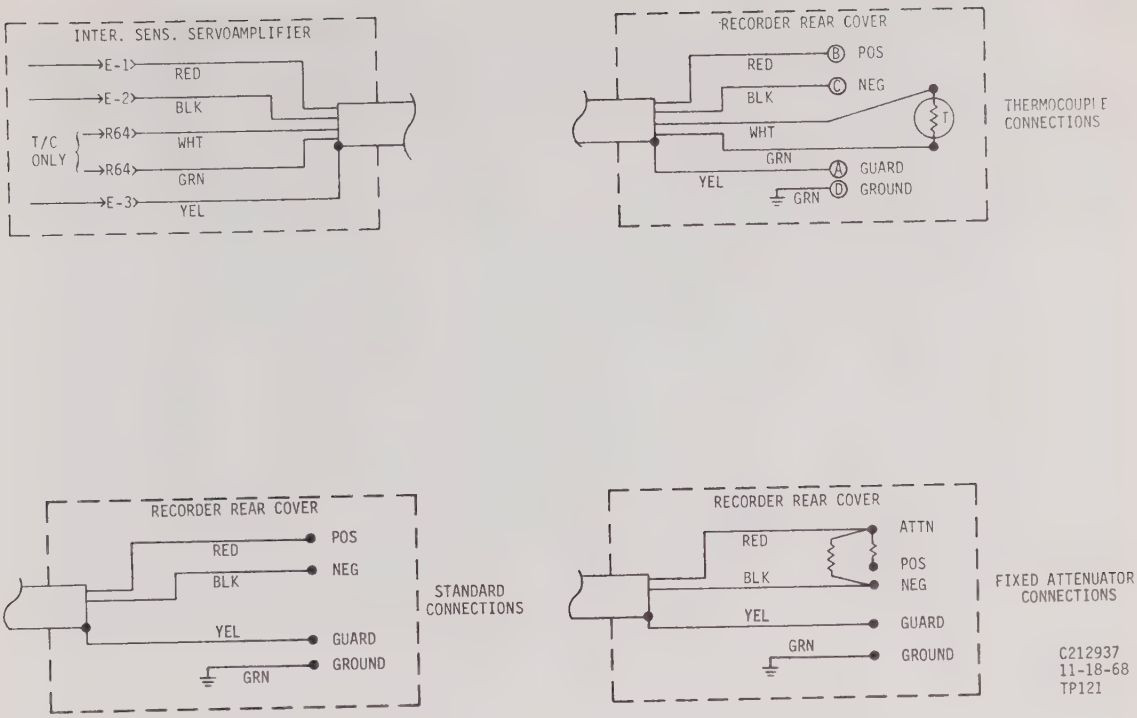


Figure 2-5. Input Connections, Wiring Diagram

amplifier power supplies to come up to full operating voltage.

2-3.2 CHART CARRIAGE. Check the chart carriage operation. When the power switch is ON, both the top drive roller and the takeup spool are driven by the chart drive motor. The paper sprocket holes should match the sprocket teeth. If they do not match, check for damage to the rollers and chart roll suspension points.

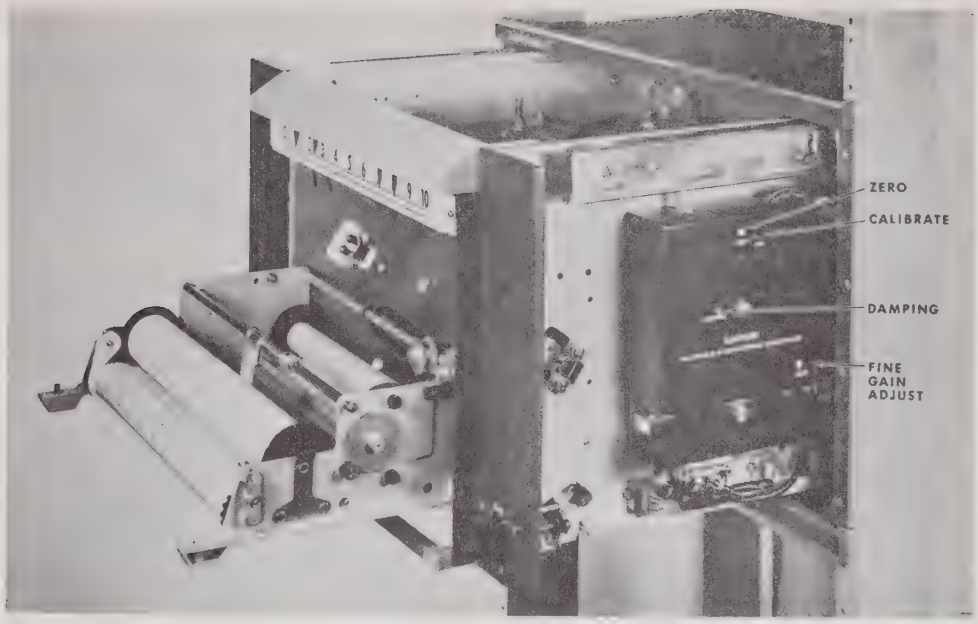
2-3.3 DEADBAND AND GAIN. Check the deadband of each channel and adjust the gain if necessary.

To check deadband:

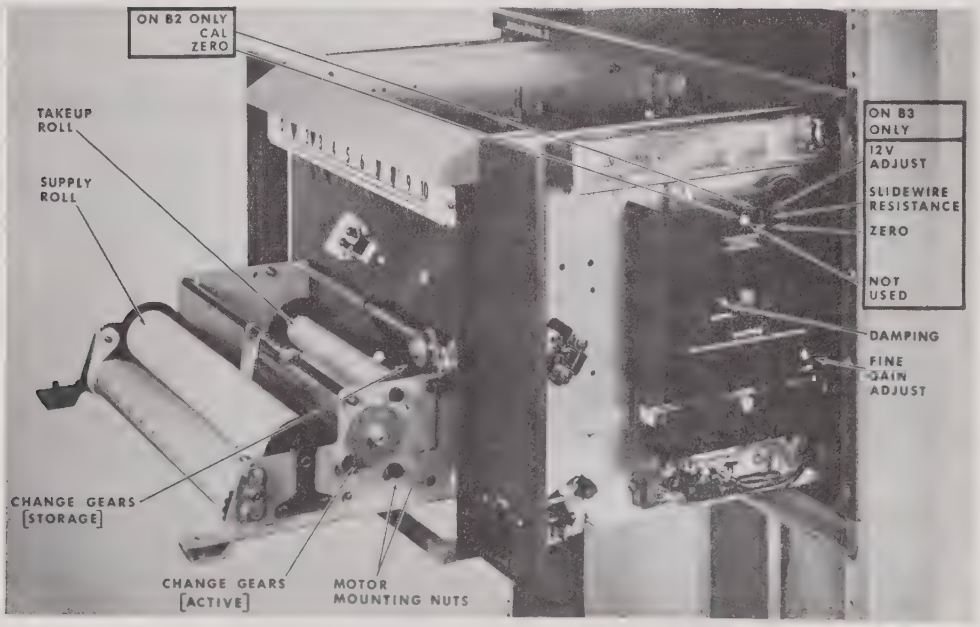
a. Pull the recorder chassis out (on its slides).
b. Use the pulley on the servomotor shaft to move the pen pointer one way and then the other on its scale. Allow the pointer to come to rest slowly each time and note the rest position.
c. The deadband of this channel is the difference between these two rest positions in percent of full span. (See Paragraph 3-4.2 for detailed description.)
d. Deadband may be decreased by advancing the gain control.

2-3.4 ZERO CONTROL. Check the zero control operation. Use a screwdriver to turn the ZERO potentiometer on the amplifier. If the gain has been set right, the pen pointer should follow closely. Be careful not to turn the CAL potentiometer by mistake. (Figure 2-6). On recorders with three span continuous zero control, the zero control is a knob on the front panel.

2-3.5 INKING SYSTEM. Fill the ink reservoirs and prime each pen. See Section 3 for complete details.



B1 ELECTRONICS



B2 AND B3 ELECTRONICS

Figure 2-6. Chart Loading and Location of Controls

SECTION III
OPERATING INSTRUCTIONS

3-1. CHART LOADING.

Remove the takeup roll containing the old chart from the recorder (Figure 2-6). This is done by pressing the spring latches outward to release and pulling the roll forward. If the roll is full, lift up on the handle-latch bar and pull the chassis out far enough to reach underneath and behind the paper roll.

Pull out the flanged hubs from the old chart and the recorder is ready for a new roll of chart paper. To reload:

a. Insert the flanged hubs into ends of a new chart roll. To prevent tapering the roll, insert both hubs lightly and then push tight with both hands.
b. Swing the chart carriage open by pulling on grips at each side of the top of the chart carriage.
c. Remove the empty supply spool and hubs by releasing the spring latches.
d. Insert the new chart roll with flanges into supply position with the round sprocket holes of the chart to the left.
e. Pull out about 14 inches of chart and wrap around the drive sprocket, engaging the teeth in the chart holes.
f. Close the chart carriage.
g. Tape the end of the chart to the chart core from the old supply roll, and insert into takeup position at the bottom of the chart carriage.
h. Roll the takeup hub flanges until the chart is tight.

3-2 INKING.

a. Using the ink syringe supplied with the recorder, slowly fill the inkwell about 7/8 full. Do not seal the entrance hole with the rubber tip of the syringe and the inkwell will fill without bubbling.
b. To prime the pen, press the rubber tip of the ink syringe snugly against the entrance hole and apply enough pressure to start ink flowing. Remove the syringe from the inkwell opening before releasing the bulb pressure to avoid suction of ink back into the inkwell. Blot up excess ink from the chart with a piece of tissue.

3-3 CHASSIS HANDLE AND SLIDES.

The chassis is mounted in the case on extension slides and is latched in by a combination handle-latch bar. To release the latch, pull up on the bar at the lower front edge of the chassis. The chassis now can be pulled straight out to the stops. On the wide-carriage recorder, a release is provided on each slide if the chassis is to be removed completely from the case. To remove the chassis completely from the case on the narrow-carriage recorder, lift up the chassis and pull it out.

3-4 ADJUSTMENT OF CONTROLS.

The location of internal controls is illustrated in Figure 2-6.

WARNING

Some controls are located near or beneath the input cover. This cover is at the input potential above ground and if the input signal is at a dangerous potential above ground, this potential will be dangerous to personnel.

3-4.1 POWER SWITCH. The power switch is located on the lower right front panel on the wide-carriage recorder and inside the chassis rear panel (near the top of

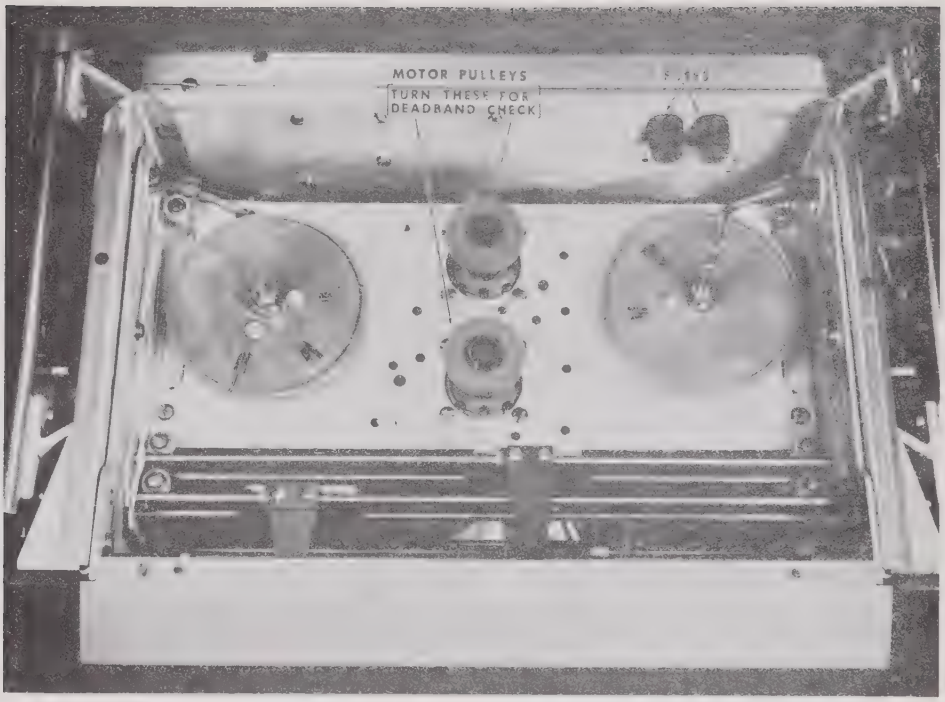


Figure 3-1. Servomotor Drive (Wide-Carriage Recorder Shown)

the recorder) on the narrow-carriage recorder. It functions as follows:

Position	Description of Power
OFF	Both sides of the power disconnected from all circuits in the recorder with exception of the fuses
STANDBY	Amplifier power on, servomotors and chart drive off
ON	All circuits on

3-4.2 GAIN ADJUST. The fine gain adjust is a screwdriver adjustment control on the lower right portion of the amplifier. This control works by changing feedback. On the B1 amplifier, clockwise rotation increases the feedback and reduces the gain. On the B2 and B3 amplifiers, clockwise rotation reduces feedback and increases the gain. The total range of this control is about two and one half to one gain change. The coarse adjustment of gain is provided by plugging in the proper resistor in the sockets on the amplifier board. Change this resistor only when the span of the recorder is changed. For proper gain setting, advance the control clockwise until the deadband is less than 0.1% of the chart width or about equal to one-half the width of a pen line. Deadband is measured from two rest positions. The first is obtained by rotating the motor pulley or capstan clockwise (CW) until the pen deflects about 3%, allowing it to return slowly to rest (Figure 3-1). Then rotate the motor pulley counterclockwise (CCW) about 3% and again allow it to return slowly to rest. The difference in these two chart positions is the deadband.

NOTE

An excessive amount of gain will cause excessive pen jitter, poor dynamic response to large step input signals, and a higher sensitivity to interference signals.

3-4.3 ZERO CONTROL. The zero control is a screwdriver adjustment on the upper center of the board providing approximately 10% adjustment of the pen around the zero position chosen. On B3 electronics the zero control provides ±3% adjustment. It is the lowest of the three square trimmers on the upper right of the board. Before attempting to adjust this control, make certain that the input signal is zero. Either short +, -, GUARD, and ground or reduce the signal source to zero. Check that the chart paper sprocket holes are aligned with the chart drive sprocket. If the recorder has a three span continuous zero control, the zero is controlled by a knob on the front panel.

3-4.4 DAMPING CONTROL. The damping control is a screwdriver adjustment control on the board. This control provides an adjustment of the dynamic performance or pen overshoot. It is a round potentiometer with a brass shaft extending through the cover.

The damping control is factory set for optimum performance for most applications. A step input signal is required for damping adjustment. If a step input cannot be obtained from the source, it may be obtained by the following steps.

a. Turn the recorder power switch to STANDBY.
b. Rotate the motor pulley to obtain the maximum pen displacement from the original balance point.
c. Return the power switch to ON.

Adjust the damping control for the desired amount of pen overshoot. Clockwise rotation of the control should reduce the amount of overshoot and counterclockwise rotation should increase the amount of overshoot. It is normally possible to obtain a smaller deadband and better frequency response if the damping control is adjusted to permit some overshoot.

3-4.5 CALIBRATE CONTROL. The calibrate control, a screwdriver adjustment control, provides approximately ±7% span adjustment on B1 and B2 electronics. On B3 electronics there are two controls which affect calibration. One of these, the upper of the three square trimmers, is used to adjust the reference power supply to precisely 12.0 volts output and has an adjustment range of about ±7%. The other control is used to adjust the resistance of the feedback potentiometer. It is the center square trimmer and has a range of about ±2%. The control is factory set for specified accuracy. Do not reset unless proper equipment is available and proper precautions are followed.

Since the servo/riter® II recorder is a precision measuring device, the equipment required to adjust the span should be relatively free of interference signals and supply a dc voltage accurate from 0.01% to 0.025% and equal to the span desired. Before attempting to calibrate the recorder, recheck and carefully reset the gain and zero control settings if required. The calibration voltage can then be applied and the calibrate control adjusted until the pen rests exactly on the outer grid line of the chart. Because humidity changes affect chart paper width slightly, the instrument may be calibrated to the front scale if desired.

3-5 CHANGING RANGE.

WARNING

Input cover is at input potential as described in Paragraph 3-4.

The plug-in range resistors are accessible by removing the upper cover of the electronics board (Figures 3-2, 3-3, and 3-4). The SPAN resistor is designated R6 on the board. If it is desired to change the span, the resistor used must have No. 20 wire leads which are capable of being bent perpendicular to the board with 0.6-inch spacing. The resistor must have leads and resistance wire with low thermal electromotive force against copper and non-inductive winding.

When the span resistor is changed, it is usually necessary to change R14 which provides a coarse gain adjust. R14 is a standard 1/2-watt carbon composition resistor with No . 20 leads. See Figures 3-2,

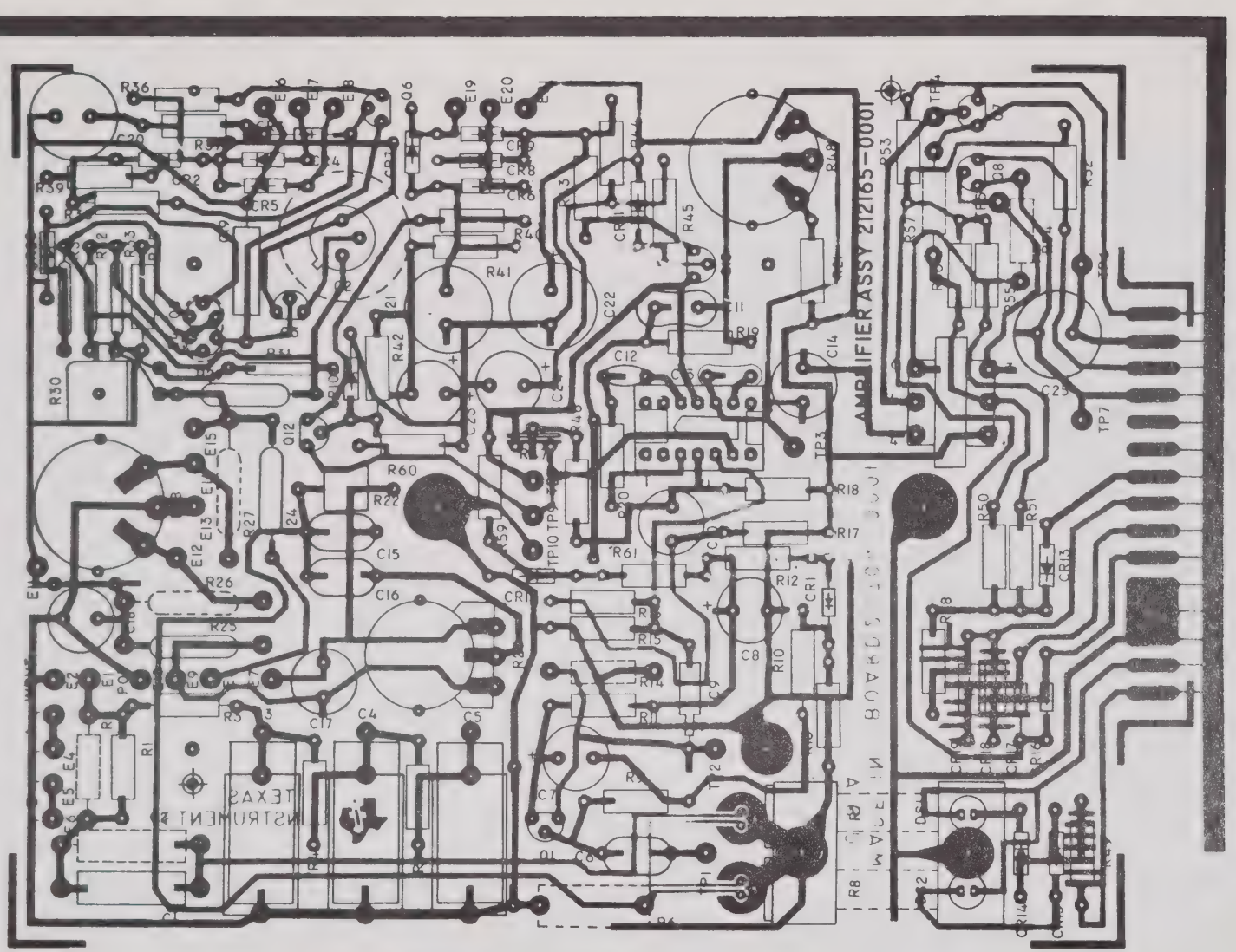


Figure 3-2. B1 Input Board

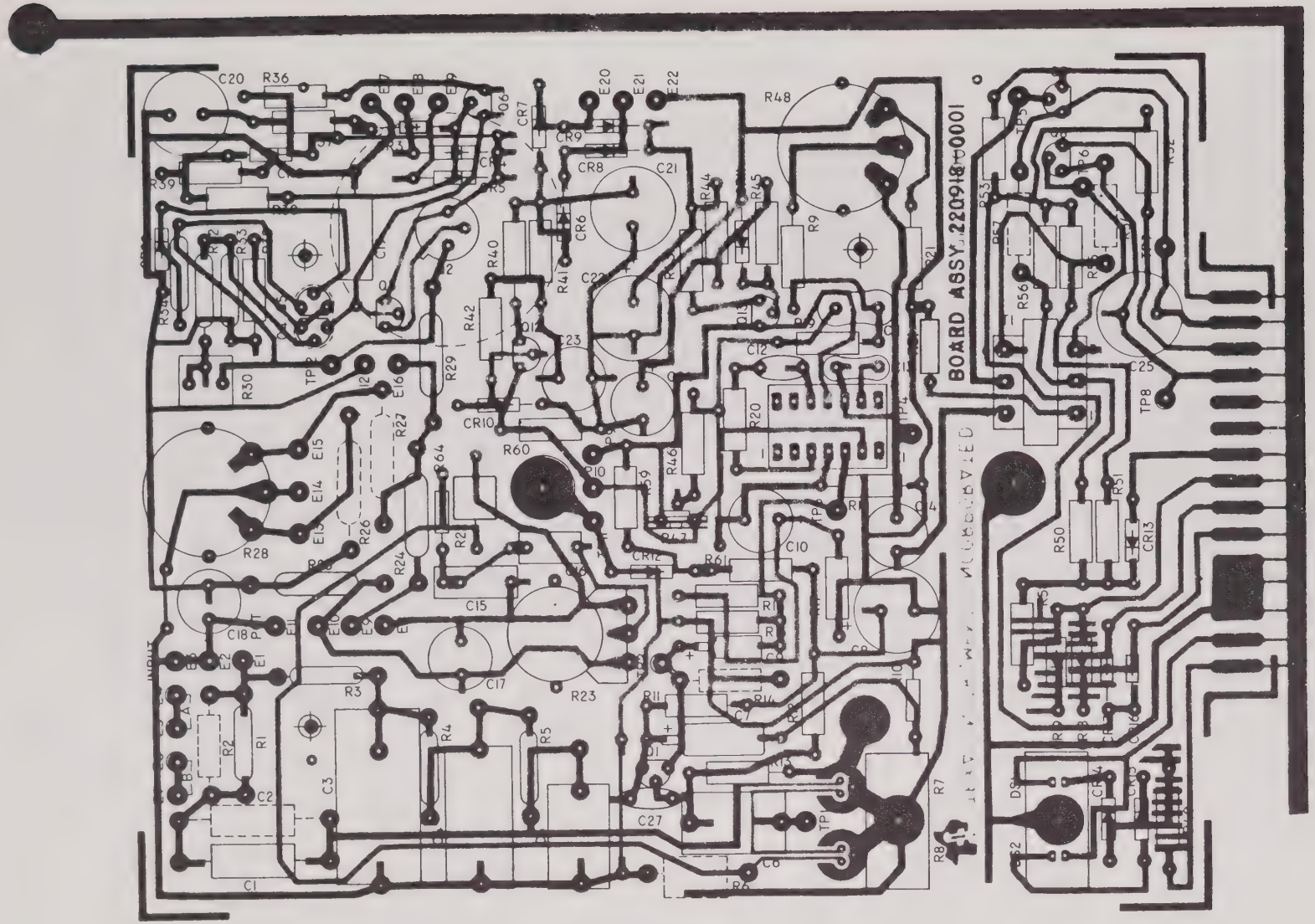


Figure 3-3. B2 Input Board

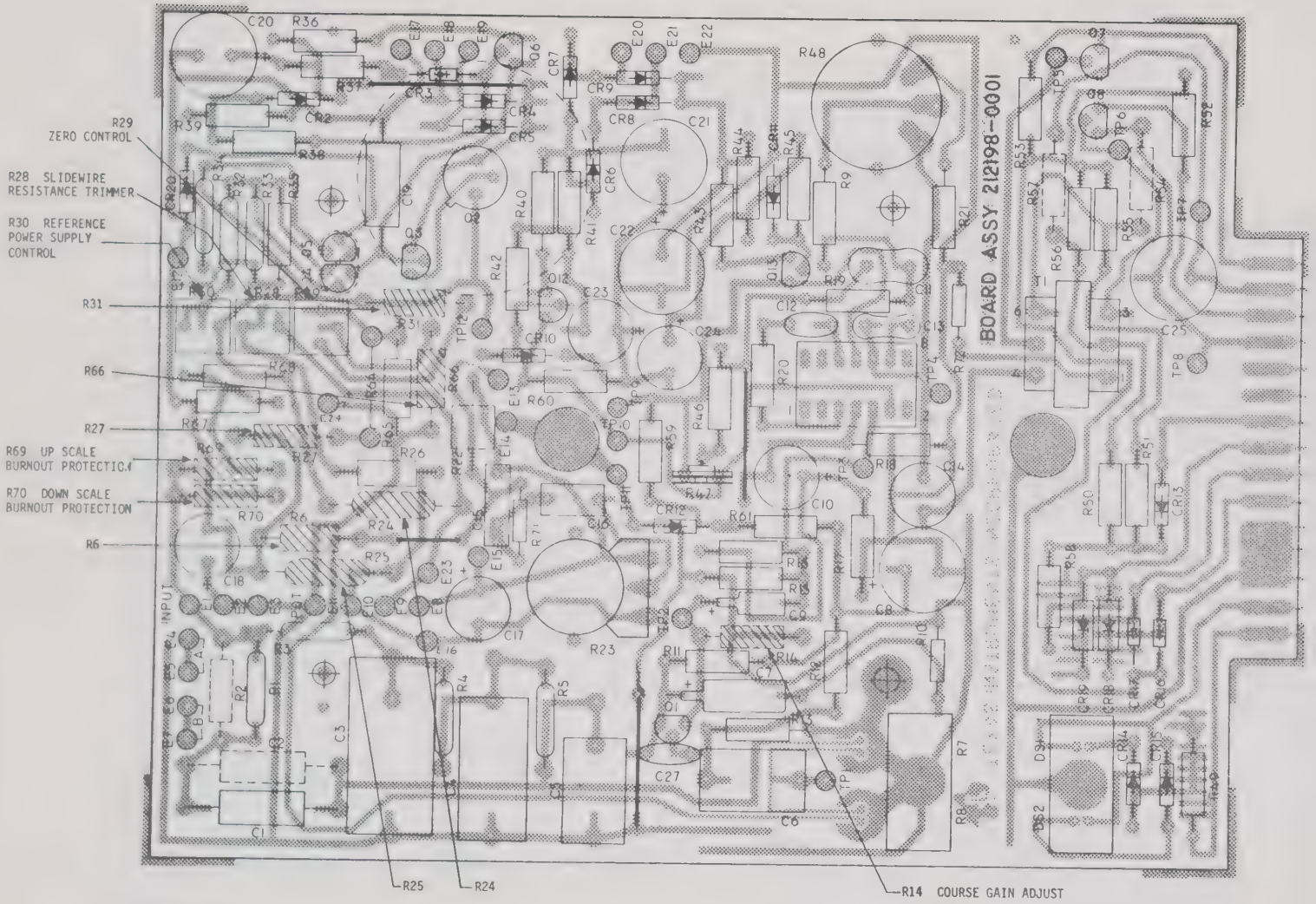


Figure 3-4. B3 Input Board

3-3, and 3-4 for the locations of R6 and R14. The values for R6 and R14 can be found in Figure 3-5. The values given for R14 are approximate and the optimum value is subject to considerable variation due to manufacturing tolerances.

The zero position resistors R26 and R27 determine the location of the ±10% zero adjust range. Resistors for these locations require No. 20 lead wires capable of being bent to plug into the board with 0.8-inch spacing. The zero position resistors are used at relatively high level so that the low thermal electromotive force materials and non-inductive winding are not essential. The resistor values required for various zero locations are given in Figure 3-5, and their locations in Figure 3-2 or 3-3.

Figure 3-6 shows the measuring circuit schematic of the B3 electronics system. The values of resistors R6, R24, R25, R31, and R66 are determined by the type of thermocouple used and the temperature range desired. The same feedback potentiometer is used for either type of electronics so that the nominal resistance values shown in Figure 3-6 are applicable. Generally, the voltage across the active region of the feedback potentiometer is set to 1381 millivolts nominal although in a few cases it is set to 700 millivolts. A computer program exists for computing these resistors and many ranges have been computed.

The B3 electronics is also used with universal range and position systems and for millivolt ranges which are highly suppressed or elevated. Figure 3-6 shows the locations for R6, R24, R25, R31, and R66.

3-6 CHART CARRIAGE.

3-6.1 SELECTION OF CHANGE GEARS. Six change gears are supplied with the basic chart carriage, providing five different chart speeds with each chart drive motor. Each gear is stamped to show the number of teeth. Tables 3-1 and 3-2 present data for gear selection (Table 1-1 is filled in on manuals shipped to accompany instruments and shows code number of the motor). The change gears in use are on the right side of the chart carriage and can be seen when the carriage is swung open. The change gears not in use are stored on a long screw mounted behind the takeup area. A multispline setscrew wrench is supplied and secured in a clip on the right side of the carriage.

Other change gears that are available include the following ratios: 3:10, 1:3, 3:8, 2:5, 3:7, 3:5, 2:3, 3:4, and 4:5. These gears can be used as step-down or step-up ratios. Two other sets, 1:5 and 1:6, are available as step-down ratios only.

3-6.2 MOTORS. The AE, BE, CE, DE, AM, BM, CM and DM motors are designed for quick, easy changing so the recorder can be used for different speed ranges with a minimum of downtime and effort.

Changing these motors requires only the following steps.

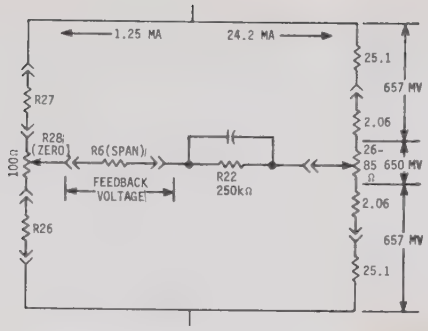
a. Remove lower change gear from motor shaft.
b. Remove the two black thumbnuts that secure motor to chart carriage.
c. Pull motor off carriage, unsnap motor cable clip from carriage cross rod, and unplug motor cable connector.
d. Install the new motor by doing steps a. to c. in reverse order.

Requirements of the system dictate that the higher-speed motors be changed by competent personnel.

3-6.3 OTHER FEATURES. The front platen on the chart carriage supports the chart and provides a surface for marking on the chart. The small groove across the platen surface permits easy tearoff of the chart by running a coin, thumbnail, or pencil point across the groove.

A friction clutch and thumbwheel on the chart drive sprocket permit manual advancement or slight backup of the chart.

When using the recorder without the takeup, clip a large paper clamp or other small weight (2 ounces) to the bottom edge of the chart.



$$R6(k\Omega) = \frac{SPAN\ (MV)}{650 - SPAN\ (MV)} \times 250\ k\Omega$$

SPAN (MV)	R6	R14	
		B1	B2
1	385.2		43k-24k
2	771.6	56k-27k	30k-15k
5.0	1938.0	47k	20k-4.7k
10.0	3906.3	24k	4.7k-3k
50.00	20,833	5.1k-3k	1.2k-820
100.00	45,455	2k-1.3k	820-470

B2
R14
43K
30K
13K
6.2K
1.8K
1.1K

THE ZERO POSITION IS THE NOMINAL POSITION WITH R28 WIPER IN THE CENTER.

$$R26 = \frac{657MV + \frac{ZERO\ POSITION\ (\%\ FULL\ SCALE)}{100} \times 650MV}{1.25\ MA} - 50\Omega$$

R27 = 1468 - R26

ZERO POSITION FROM LEFT MARGIN	R26	R27
LEFT (-1%)	468	1000
RIGHT (101%)	1000	468
CENTER (50%)	750	750
-92%	0	1468
+192%	1468	0
-71%	108	1360
-48%	228	1240
-32%	308	1160
-17%	388	1080
+6%	508	960
+29%	627	841
+71%	841	627
94%	960	508
117%	1080	388
132%	1160	308
148%	1240	228
171%	1360	108

FOR OTHER CALCULATED VALUES SEE DRAWING 212178.

Figure 3-5. B1 and B2 Measuring Circuit

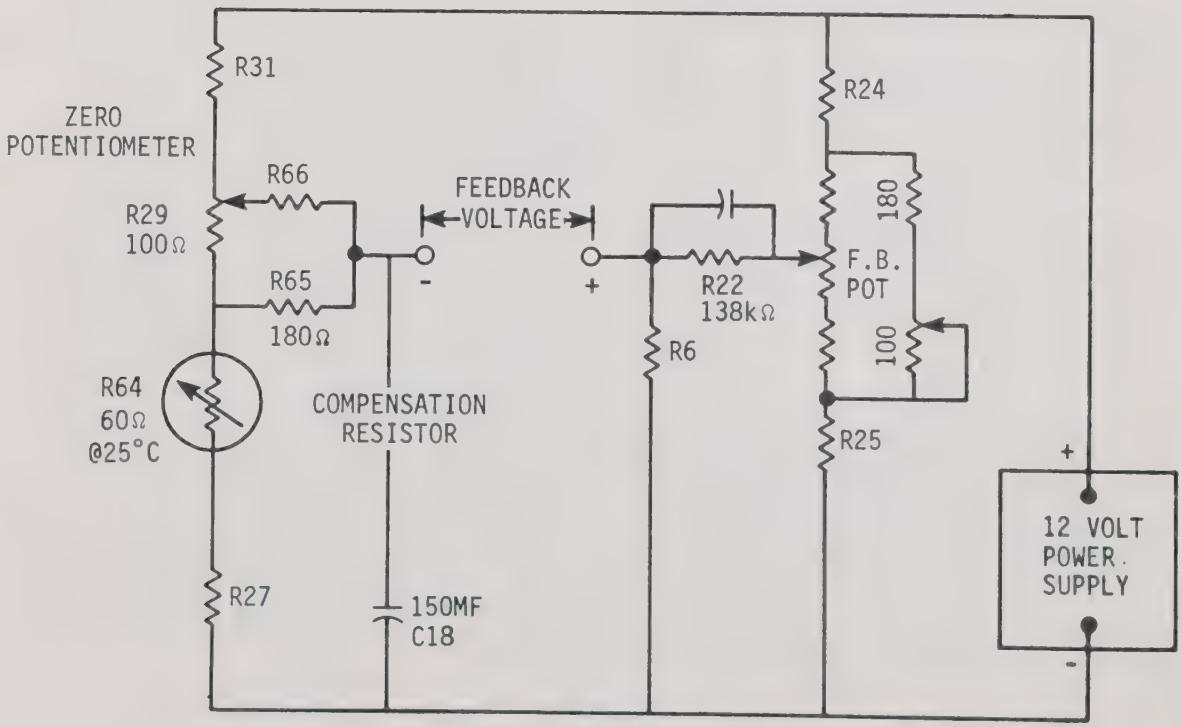


Figure 3-6. B3 Measuring Circuit

TABLE 3-1

CHANGE GEAR SELECTION, STANDARD (INCH) SPEEDS

Chart Speed Desired	Motor Code	Output Shaft Speed Required	Gears Required (No. of Teeth) and Gear Position	
			Upper	Lower
0.25 iph	AE	4 rph	72	18
0.5 iph	AE	4 rph	60	30
1.0 iph	AE	4 rph	45	45
2.0 iph	AE	4 rph	30	60
4.0 iph	AE	4 rph	18	72
1.5 iph	BE	24 rph	72	18
3.0 iph	BE	24 rph	60	30
6.0 iph	BE	24 rph	45	45
12.0 iph	BE	24 rph	30	60
24.0 iph	BE	24 rph	18	72
2.5 iph	CE	40 rph	72	18
5.0 iph	CE	40 rph	60	30
10.0 iph	CE	40 rph	45	45
20.0 iph	CE	40 rph	30	60
40.0 iph	CE	40 rph	18	72
0.25 ipm	DE	4 rpm	72	18
0.5 ipm	DE	4 rpm	60	30
1.0 ipm	DE	4 rpm	45	45
2.0 ipm	DE	4 rpm	30	60
4.0 ipm	DE	4 rpm	18	72
1.5 ipm	EE	24 rpm	72	18
3.0 ipm	EE	24 rpm	60	30
6.0 ipm	EE	24 rpm	45	45
12.0 ipm	EE	24 rpm	30	60
24.0 ipm	EE	24 rpm	18	72

TABLE 3-1 (Continued)

CHANGE GEAR SELECTION, STANDARD (INCH) SPEEDS

Chart Speed Desired	Motor Code	Output Shaft Speed Required	Gears Required (No. of Teeth) and Gear Position	
			Upper	Lower
2.5 ipm	FE	40 rpm	72	18
5.0 ipm	FE	40 rpm	60	30
10.0 ipm	FE	40 rpm	45	45
20.0 ipm	FE	40 rpm	30	60
40.0 ipm	FE	40 rpm	18	72
7.5 ipm	GE	120 rpm	72	18
15.0 ipm	GE	120 rpm	60	30
30.0 ipm	GE	120 rpm	45	45
60.0 ipm	GE	120 rpm	30	60
120.0 ipm	GE	120 rpm	18	72

TABLE 3-2

CHANGE GEAR SELECTION, METRIC SPEEDS

Chart Speed Desired	Motor Code	Output Shaft Speed Required	Gears Required (No. of Teeth) and Gear Position	
			Upper	Lower
0.625 cm/hr	AM	4 rph	72	18
1.25 cm/hr	AM	4 rph	60	30
2.5 cm/hr	AM	4 rph	45	45
5.0 cm/hr	AM	4 rph	30	60
10.0 cm/hr	AM	4 rph	18	72
3.75 cm/hr	BM	24 rph	72	18
7.5 cm/hr	BM	24 rph	60	30
15.0 cm/hr	BM	24 rph	45	45
30.0 cm/hr	BM	24 rph	30	60
60.0 cm/hr	BM	24 rph	18	72

TABLE 3-2 (Continued)

CHANGE GEAR SELECTION, METRIC SPEEDS

Chart Speed Desired	Motor Code	Output Shaft Speed Required	Gears Required (No. of Teeth) and Gear Position	
			Upper	Lower
6.25 cm/hr	CM	40 rph	72	18
12.5 cm/hr	CM	40 rph	60	30
25.0 cm/hr	CM	40 rph	45	45
50.0 cm/hr	CM	40 rph	30	60
100.0 cm/hr	CM	40 rph	18	72
0.625 cm/min	DM	4 rpm	72	18
1.25 cm/min	DM	4 rpm	60	30
2.5 cm/min	DM	4 rpm	45	45
5.0 cm/min	DM	4 rpm	30	60
10.0 cm/min	DM	4 rpm	18	72
3.75 cm/min	EM	24 rpm	72	18
7.5 cm/min	EM	24 rpm	60	30
15.0 cm/min	EM	24 rpm	45	45
30.0 cm/min	EM	24 rpm	30	60
60.0 cm/min	EM	24 rpm	18	72
6.25 cm/min	FM	40 rpm	72	18
12.5 cm/min	FM	40 rpm	60	30
25.0 cm/min	FM	40 rpm	45	45
50.0 cm/min	FM	40 rpm	30	60
100.0 cm/min	FM	40 rpm	18	72
18.75 cm/min	GM	120 rpm	72	18
37.5 cm/min	GM	120 rpm	60	30
75.0 cm/min	GM	120 rpm	45	45
150.0 cm/min	GM	120 rpm	30	60
300.0 cm/min	GM	120 rpm	18	72

SECTION IV
THEORY AND DEFINITIONS

4-1 NULL-BALANCE RECORDER THEORY.

Fundamentally, a null-balance potentiometric recorder consists of display, feedback generating, and error-detecting and amplifying functions as shown in Figure 4-1. A voltage to be measured is connected to the recorder in opposition to an internally generated feedback voltage. The difference between the voltage to be measured and the internally generated feedback is applied as the input to an amplifier. The amplifier output drives a motor which drives a potentiometer that changes the internally generated voltage until the difference voltage is very small. The motor then stops running, and the pen or print head (display element) records the amount of voltage measured. Very little current is drawn from the voltage source being measured because it is balanced by the internal feedback voltage.

4-1.1 DAMPING. In addition to these basic functions, the recorder needs damping. With a sudden change in the input signal, the error voltage may be sufficient to run the motor at full speed. But when the error voltage reaches zero, the motor inertia prevents a sudden speed drop to zero. Without damping the recorder can overshoot the proper balance point and go into steady oscillation, first overshooting on one side and then the other side of the balance point. The damping system develops a voltage proportional to the speed and feeds it into the amplifier so that the motor torque is reversed shortly before the system reaches the balance point. This brings the motor to a stop just as the feedback voltage equals the voltage to be measured.

4-1.2 FILTERING. A filtering system reduces stray voltages in the system. For

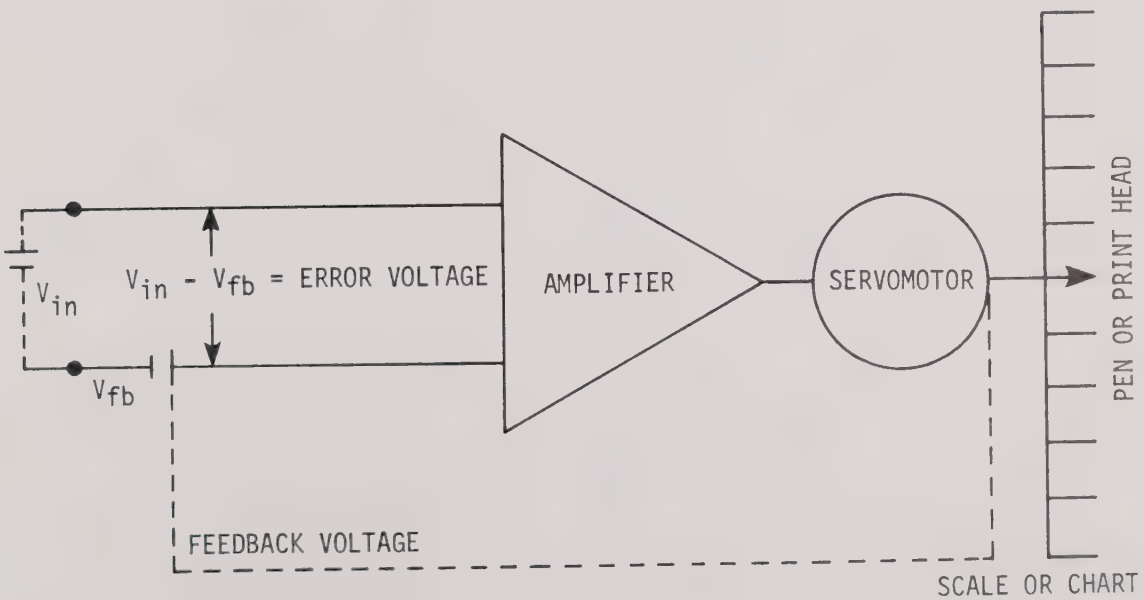


Figure 4-1. Simplified Recorder Diagram

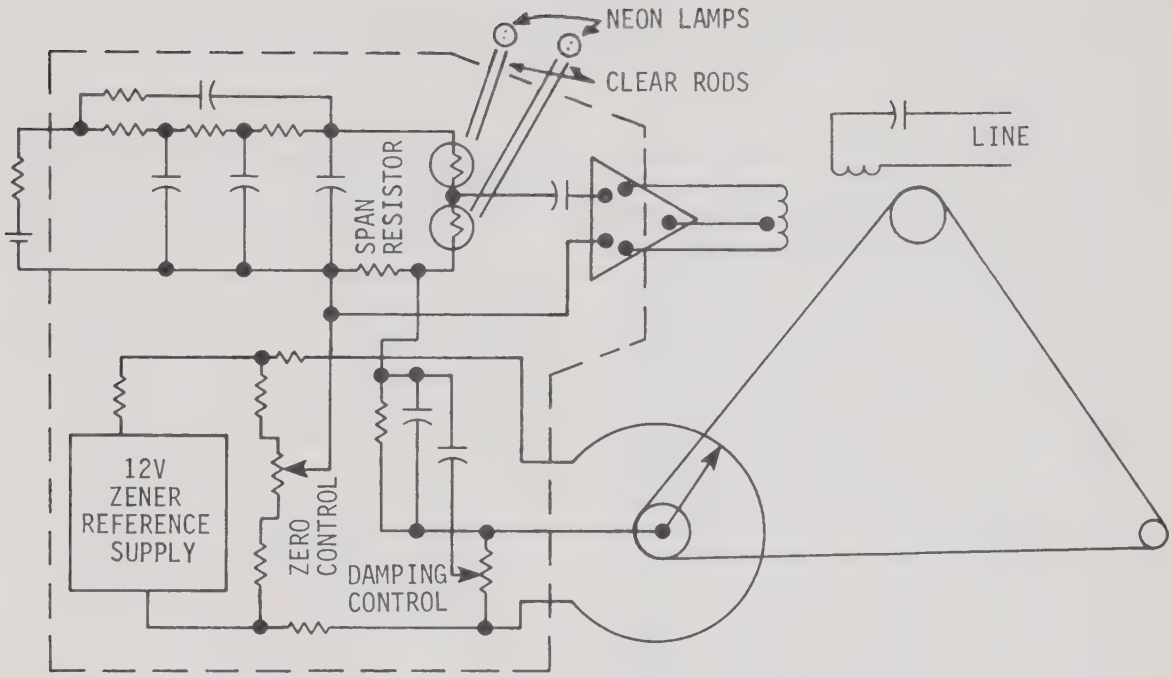


Figure 4-2. Simplified Recorder Schematic

a recorder design of 1-millivolt full-scale measurement, the amplifier gain must be such that an input of approximately 20 microvolts drives the amplifier into saturation. This illustrates the importance of eliminating stray voltages.

To reduce the effect of stray ac voltages on the system, a low-pass filter is placed in cascade with the input. This filter is designed to pass the signal frequencies and block higher frequencies.

4-1.3 COMMON-MODE ISOLATION. It is possible for the voltage source to be measured at some ac or dc voltage with respect to ground. Isolation is necessary to measure the voltage of the source without having the measurement upset. The portion of the system generating the feedback and error voltage, and possibly some portion of the amplifier must be isolated so the effective error voltage is not affected by voltages with respect to ground. This function is called common-mode isolation.

There are a number of methods used to accomplish common-mode isolation. In the servo/riter® II B and multi/riter*B the entire input, feedback, and the low-level portion of the amplifier are enclosed in a guard shield. This includes the secondary windings of the power transformer which supply the reference power supply and the amplifier power supply. The output of the low-level amplifier is coupled to the grounded power stage through an interstage transformer which passes the signal but does not pass common-mode voltages.

4-1.4 THEORY OF THE SERVO/RITER® II RECORDER WITH TYPE B ELECTRONICS. Figure 4-2 is a simplified schematic representation of the servo/riter® II recorder with type B electronics. The display element is a pen moving across a paper chart which is advanced by a synchronous motor.

Subsections 4-2 through 4-7 explain the theory of the recorder in detail.

4-2 FEEDBACK.

The feedback element is a circular continuous wire. A stable voltage is impressed across the element from a zener-diode regulated power supply. The contact to the resistance element is mechanically coupled to the display element by a flexible stainless-steel cable, pulleys, and a ball-bearing mounted shaft. This coupling causes the contact to move accurately along a circle as the display element moves linearly. The same stainless-steel cable is wound on a pulley on the servomotor shaft.

The high resolution of a single strand of wire makes it desirable for the resistance element. The active region of the wire is approximately 27 ohms, and the total resistance is approximately 31 ohms. Making all the wires and connections follow paths close to the main slidewire results in a minimum of magnetic-field pickup. The sliding contact of the feedback element bridges from the slidewire to a pickup wire rather from a pickup circuit along the pickup arm. The recorder is designed for easy span change. Consequently, for all normal spans, the voltage across the active portion of the wire is maintained at a fixed value of about 650 millivolts.

To obtain the proper voltage for recorders of 1-millivolt to 100-millivolt span, the slidewire span of 650 millivolts is reduced by a resistance divider. One of the resistors in the divider, 250 kilohms, is the dropping resistor. The other resistor, across which the feedback voltage is developed, varies from 385 ohms for a 1-millivolt span up to 45,455 ohms for a 100-millivolt span. This resistor is called the feedback resistor.

To control the point at which the recorder reads zero, the voltage impressed across the slidewire is also impressed across a second resistance divider. The span-controlling divider is returned to the point on this divider which matches the potential on the main slidewire at the place which corresponds to the display element position indication of zero.

The main damping function in this recorder is provided by a capacitor which shunts the 250-kilohm dropping resistor in the span-controlling divider. When the slidewire contact is in motion, the voltage across the capacitor is changing. This causes a current, which also flows through the feedback resistor, to flow through the capacitor. This extra current through the feedback resistor causes the dynamic feedback voltage to lead the static feedback voltage. Thus, the feedback voltage matches the input voltage a short time before the display element comes to the final balance point. A reversed error signal is applied to the amplifier sufficiently in advance of the balance point to bring the motor to a stop without overshooting. A second capacitor is connected to a high-resistance variable voltage divider. The voltage divider is connected from the slidewire contact to one end of the slidewire to provide a means of varying the damping.

The B3 electronics system, especially adapted to thermocouple recorders which require cold junction compensation, has a somewhat different measuring circuit. A simplified schematic of the B3 measuring circuit is shown in Figure 3-6.

4-3 FILTERING AND MODULATION.

The filter used in the type B electronics system consists of three RC sections in cascade. An RC shunting element from input to output causes a bridge balance effect at the nominal line frequency greatly increasing the rejection of the largest source of stray.

The modulator in the recorder uses two photoconductive cells. These cells have a low resistance when illuminated and a high resistance when dark. Two neon lamps are used to illuminate the photoconductors. One lamp is on during one-half cycle of the power line and the other lamp is on during the alternate half cycle. The lamps require 135 volts maximum to fire. Spacing the lamps approximately 3/4 inch from the photoconductors and guiding the light through clear rods makes the stray coupled from the lamp firing voltage to the low-level signals on the photoconductors negligible.

The input to the error amplifier is alternately connected to the input voltage and

the feedback voltage. Thus, an ac signal is applied to the ac error amplifier proportional to the difference between the input signal and feedback voltage. The effective dc input impedance at the modulator is typically 180,000 ohms in B1 electronics and 60,000 ohms in B2 and B3 electronics. This includes the effect of the input stage following the modulator.

4-4 ERROR AMPLIFIER.

The error amplifier following the modulator has a discrete transistor preamplifier stage followed by a type 709 monolithic integrated operational amplifier. The output of the integrated amplifier is fed to the primary of an interstage transformer with two secondaries. The two secondaries feed two push-pull connected power transistors through Darlington connected driver transistors. The power transistors feed the centertapped control winding of the servomotor whose reference phase is fed from the ac line through a phase shifting series capacitor.

In B1 electronics, as shown in Figure 4-3, the amplifier first stage is operated at low current (approximately 100 microamperes) for low noise. The voltage gain of the stage is controlled by the collector load resistance value which consists of R14 in parallel with R15 and the input impedance of the following stage. Since R14 is a plug-in resistor it can be used for setting the voltage gain of the first stage. The gain is stabilized and the input impedance is raised by the emitter resistor R11 paralleled by R10 and R12 in series. The emitter voltage is fed to the end of R9 opposite the base connection which bootstraps R9 and raises its effective resistance value. The diode CR1 is used as temperature compensating element to balance the temperature variation of the base-emitter junction of the transistor keeping the bias current relatively constant while the ambient temperature varies widely.

The gain obtained when the maximum permissible value of R14 is used (56 kilohms) is typically 10:1 from the input terminals of the recorder to the peak-to-peak voltage at the collector of the transistor (Test Point 2).

The input stage of the B2 and B3 amplifiers (Figures 4-4 and 4-5) differ from the input stage of B1. The bias voltage applied across the base-emitter junction of the transistor and the 6200-ohm resistor is set to 1.2 volts. The transconductance of the transistor is nearly constant with temperature. This condition results because the tendency of the dynamic resistance of the base-emitter junction of the transistor to increase when temperature is compensated by an increase of bias current with temperature due to a drop of the base-emitter voltage with temperature. The 6200-ohm resistor in the emitter is bypassed by a 47-microfarad capacitor in series with a 390-ohm resistor. The 30-kilohm resistor and the 120-kilohm resistor, which serve as the bias setting divider, are low noise film resistors. This stage provides a higher voltage gain, lower noise, but a smaller input impedance than the input stage of the B1 electronics.

The output voltage from the preamplifier stage is fed through a 0.47-microfarad capacitor to the non-inverting input of the monolithic amplifier. The inverting input is used for the stabilizing feedback from the output which provides both dc stability and signal frequency gain stability. When the potentiometer R48 is at the top, the feedback ratio is about 1000:1. The potentiometer has a series resistor so that it can increase the feedback attenuation by a maximum factor of 8:3. The open-loop gain of the amplifier will exceed 20,000 so that the closed-loop gain varies from 1,000 to 2,300. The capacitor shunting the 6.8-megohm feedback resistor serves to eliminate some of the high-frequency noise. The potentiometer R47 in conjunction with the 22-megohm resistor R46 adjusts the initial offset of the integrated amplifier. The capacitor C10 bootstraps the resistor R16 which carries the dc base current of the amplifier non-inverting input. This raises the input impedance. Since the amount of bootstrapping is dependent on the open-loop gain of the amplifier (variable from unit to unit), R15 is added in parallel to cancel some of these variations. Because this reduces the input impedance tolerance, the phase shift variations caused by coupling capacitor C9 are small and the phase shift through the amplifier

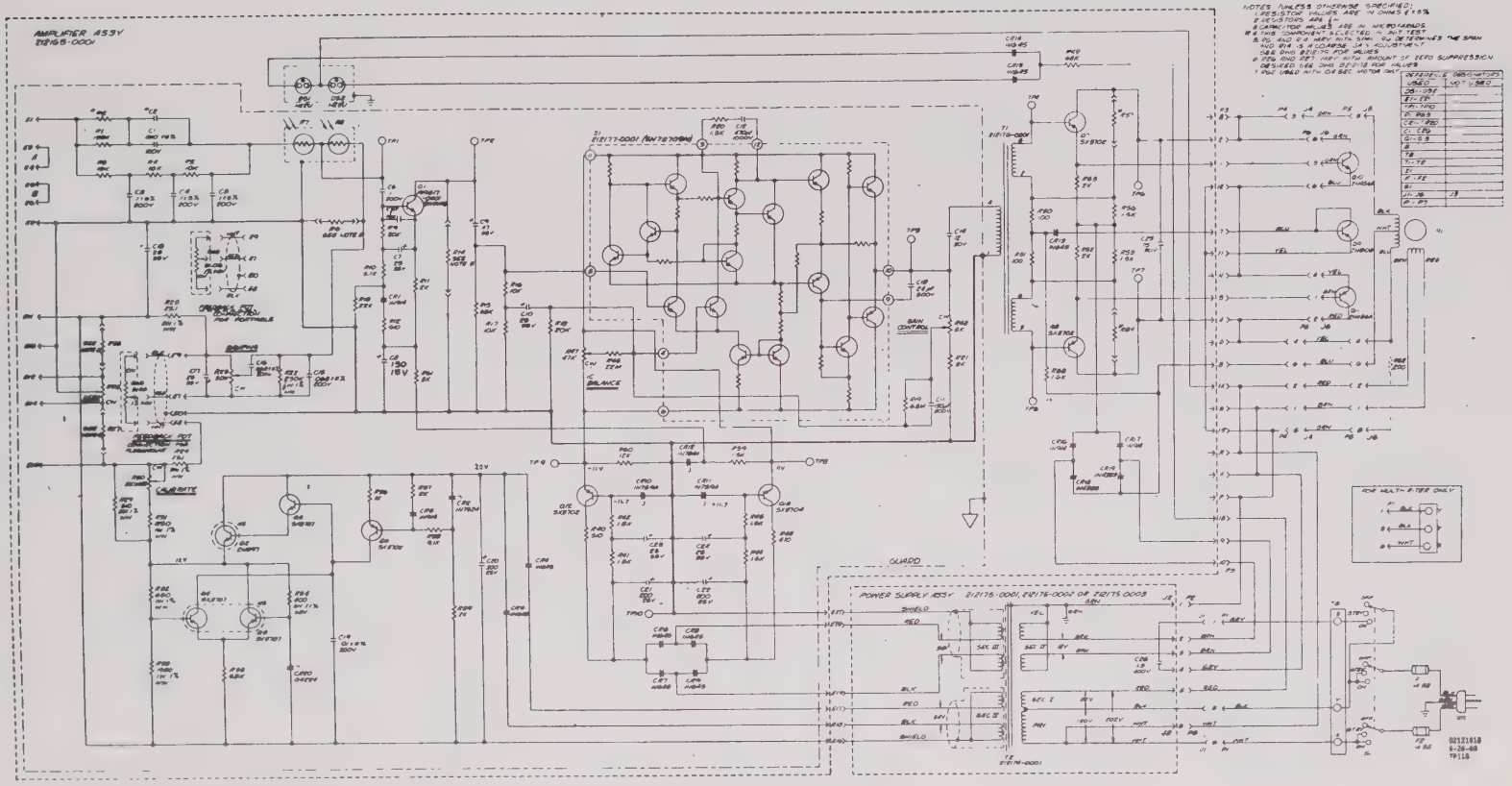


Figure 4-3. B1 Servoamplifier Schematic

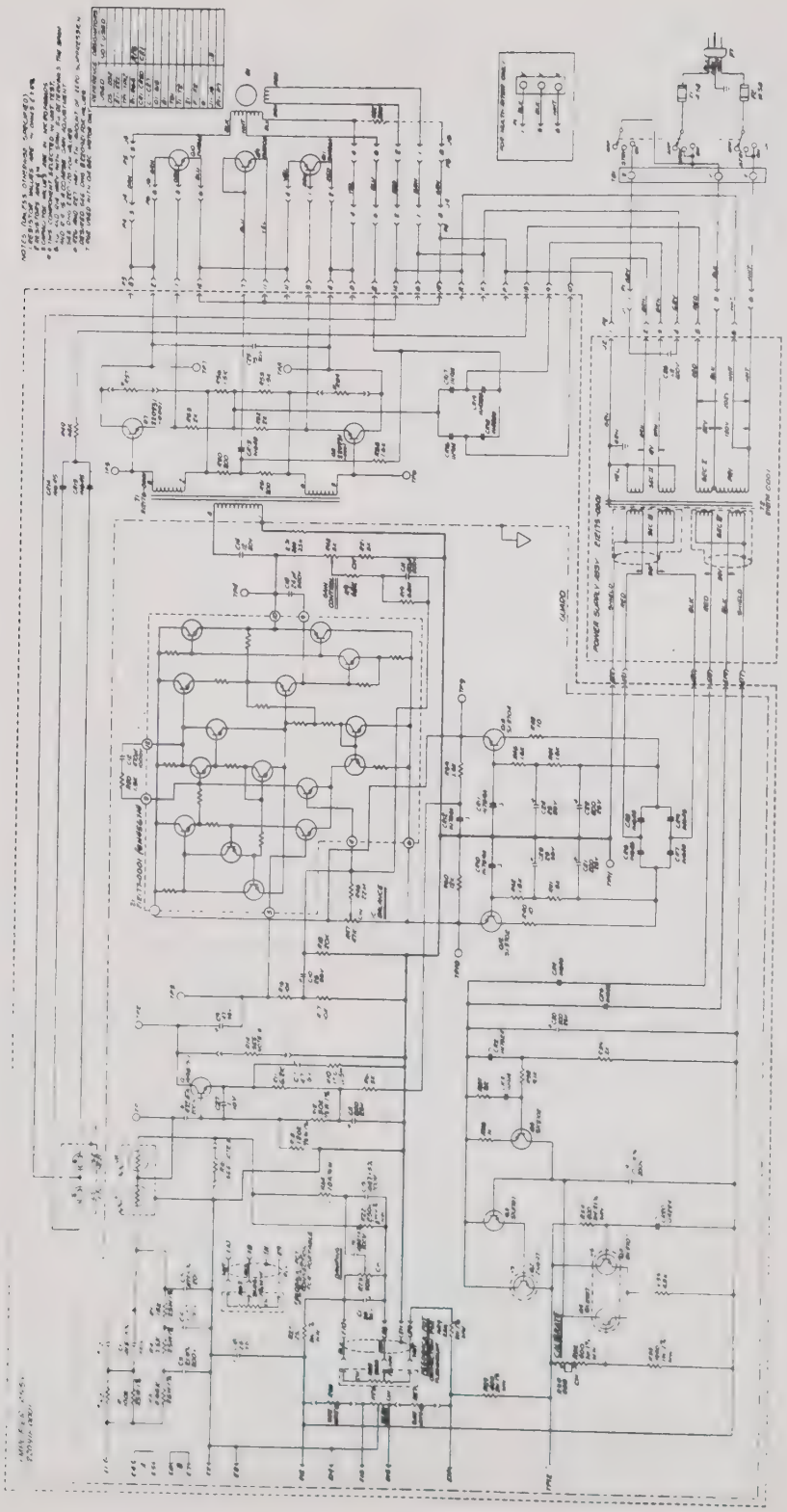


Figure 4-4. B2 Servoamplifier Schematic

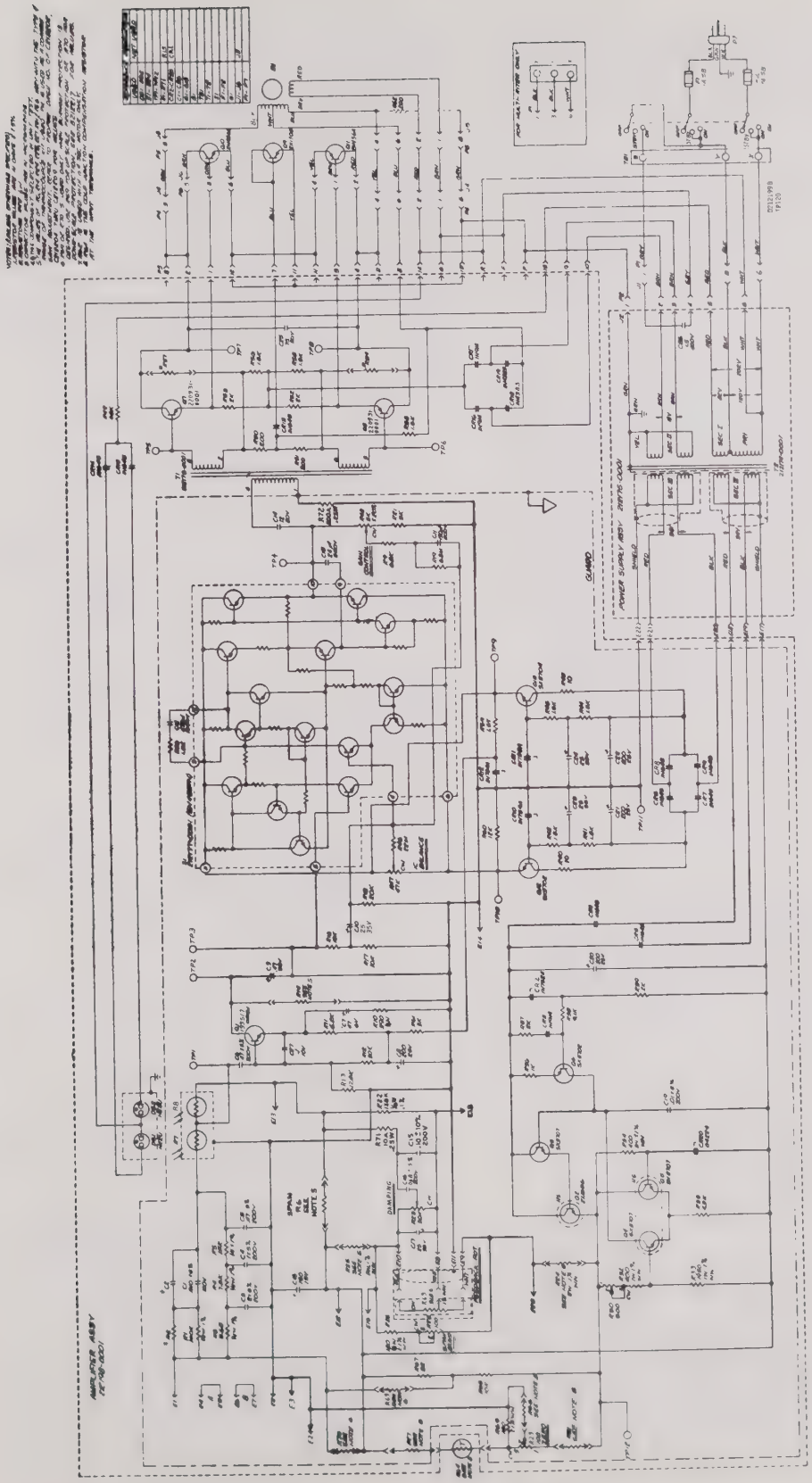


Figure 4-5. B3 Servoamplifier Schematic

has fairly tight tolerance. Resistor R31 is added in series with the output to limit current and dissipation in the integrated circuit when it is saturated.

The output of the integrated amplifier is fed to the interstage transformer which feeds a modified Darlington connected push-pull power stage feeding the centertapped control winding of the servomotor.

Refer to Figure 4-3, 4-4, or 4-5. The silicon diode CR13 and the diode connected germanium transistor Q9 develop a biasing voltage to balance against the base-emitter drops of the silicon transistors Q7 and Q8 and the germanium power transistors Q10 and Q11. The divider network consisting of R50, R51, R54, R55, R56, and R57 performs two functions. The primary function is to provide voltage feedback which will lower the effective ouput impedance of the power amplifier. For proper damping it is essential to provide the servomotor with a low source impedance from the power amplifier. A secondary function is to provide a factory adjustment on the power amplifier bias by selection of R54 and R57.

4-5 REFERENCE POWER SUPPLY.

The reference power supply is mounted on the same printed circuit board as the amplifier, feedback, and filter. It is supplied from a shielded secondary on the power transformer. The voltage developed across the compensated reference diode CR20 is compared with a fraction of the output voltage by the differential amplifier composed of Q4 and Q5. The error is amplified and used to vary the drop across the series-pass transistor Q2. Q3 is a current amplifier and Q6 provides a constant current source for a collector load for Q4.

4-6 CHART CARRIAGE.

The chart carriage assembly provides chart drive and chart control function. A synchronous motor geared to a chart driving sprocket engages precision holes in the chart. The supply roll is held in place just below the drive sprocket. A spring-loaded finger presses against the outer layer of the chart paper, providing an essentially constant holdback tension of about 3 ounces. The chart passes down the carriage front to the takeup tube at the carriage bottom. A constant-torque slip clutch is driven more than twice as fast as the chart driving sprocket. The takeup tube is driven through this slip clutch. The takeup chart tension varies by a factor of 2-1/2 times because of the varying diameter of the takeup roll. Normally, the actual takeup tension varies from more than 4 ounces at the start of a roll to less than 2 ounces at the finish.

A constant torque brake is provided on the chart driving sprocket so that the chart will not back up when the chart roll tension is lessened. A high-torque slip clutch is also provided on the chart sprocket to permit manual override to position a selected timing line of the chart directly under the display element at the start of a timed run.

Various optional drives are available in place of the standard low-speed motor drive. The servo/riter® II Parts List Manual lists these drives.

4-7 DEFINITIONS.

The definitions which follow are quoted from the American Standards specifications for "Automatic Null-Balancing Electrical Measuring Instruments" (C39.4-1966).

Rated Accuracy. The limit which errors will not exceed when the instrument is used under any combination of rated operating conditions. It is usually expressed as a percentage of span. Rated accuracy does not include accuracy of sensing elements or intermediate means external to the instrument.

Deadband. The range through which the measured signal can be varied without initiating response. This is usually expressed in percent of span.

Deadband Rating. The limit which the deadband will not exceed when the instrument is used under rated operating conditions.

Interference. Any spurious voltage or current appearing in the circuits of the instrument.

Common Mode Interference. A form of interference which appears between any measuring circuit terminal and ground.

Normal Mode Interference. A form of interference which appears between measuring circuit terminals.

Operating Conditions. Conditions (such as ambient temperature, ambient pressure vibration, etc.) to which a device is subjected, but not including the variable measured by the device.

Extreme Operating Conditions. The range of operating conditions within which a device is designed to operate and under which operating influences are usually stated.

Rated Operating Conditions. The limits of specified variables or conditions within which the performance ratings apply.

Range. The region between the limits within which a quantity is measured, expressed by stating the lower and upper range-values. For multirange devices, this definition applies to the particular range that the device is set to measure.

Electrical Range. The range expressed in equivalent electrical units.

Lower Range-Value. The lowest quantity that a device is adjusted to measure.

Upper Range-Value. The highest quantity that a device is adjusted to measure.

Elevated-Zero Range. A range where the zero value of the measured variable, measured signal, etc., is greater than the lower range-value. The zero may be between the lower and upper range-value, at the upper range-value, or above the upper range-value.

Suppressed-Zero Range. A range where the zero value of the measured variable, measured signal, etc., is less than the lower range-value. Zero does not appear on the scale.

Suppression Ratio (of a Suppressed-Zero Range). The ratio of the lower range-value to the span.

Step-Response Time. The time required for the end device to come to rest in its new position after an abrupt change to a new constant value has occurred in the measured signal.

Span Step-Response-Time Rating. The limit which the step-response time will not exceed for a change in measured signal essentially equivalent to full span when the instrument is used under rated operating conditions. The actual span step-response time shall not be less than 2/3 of the span step-response-time rating. It must be recognized that the step-response time for smaller steps is not proportional to the step-response time for full span. The end device shall be considered to be at rest when it remains within a band of plus and minus the accuracy rating from its final position.

Source Resistance. The resistance presented to the input of a device by the source.

Source Resistance Rating. The value of source resistance which, when injected in an external circuit having essentially zero resistance, will either (1) double the deadband, or (2) shift the deadband by one-half its width.

Span. The algebraic difference between the upper and lower range-values. For multirange devices, this definition applies to the particular range that the device is set to measure.

Transient Overshoot. An excursion beyond the final steady-state value of output as the result of a step-input change. It is usually referred to as the first excursion; expressed as a percent of the steady-state output step.

SECTION V

COMPUTER READOUT AND INDENTED PARTS LIST

On the following parts list, the first major assembly level that is indicated in column 1 (ASSY LEV -) is 01. All items listed for this major assembly level (01) carry the number 02, and the applicable parts numbers are indented under the 01 entry. The number 03 is used for items under 02 items, etc. The numbering and indenting continue to increase down to the smallest component listed. Each assembly, subassembly, or component is referenced under the PRINT ITEM column to item numbers that appear on the blueline assembly drawings. The blueline assembly drawing number is listed in the upper-left of each page, under the date.

212165-0001 B SERVO AMP ASSY-

ASSY LEV	PART NUMBER	REV LTR	DESCRIPTION	UM	PRINT ITEM	QUANTITY PER
01	*211704-0002	*	BOARD-AMPLIFIER	EA	0001	00001.000
02	**211704-0001	*	BOARD-AMPLIFIER DRILLED & SCREENED	EA	0005	00001.000
02	**232671-1125		PIN FORMED .058 DIA GOLD PLATED	EA	0006	00031.000
02	**235320-0100		SOCKET SPRING .030-.033 PIN	EA	0007	00014.000
02	**235319-9000		SOCKET SPRING .018 TO .021 PIN DIA GOLD	EA	0008	00002.000
01	*212168-0001		COVER-GUARD	EA	0002	00001.000
01	*212167-0001	A	COVER-GROUND	EA	0003	00001.000
02	**237461-0001		STL. SHT. .0359 20 GA. COLD RO	SF	0001	00000.150
01	*212169-0001	*	PLATE-GUARD	EA	0004	00001.000
02	**237461-0001		STL. SHT. .0359 20 GA. COLD RO	SF	0001	00000.250
01	*212170-0001	*	STANDOFF-COVER	EA	0005	00002.000
02	**236820-0000		AL.ROD 3/8 2011-T3	IN	0001	00001.500
01	*212171-0001		RETAINER-AMPLIFIER	EA	0006	00004.000
02	**236869-0000		AL.HX ROD 1/4 2024-T4	IN	0001	00001.625
01	*212173-0001		BRACKET-CALIBRATE POT.	EA	0007	00001.000
01	*184824-0001	E	HOUSING-LAMP	EA	0008	00001.000
02	**236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00017.283
01	*184836-0002	G	ROD LIGHT	EA	0009	00002.000
01	*212180-0001	*	HOUSING ASSY,PHOTOCONDUCTOR	EA	0010	00001.000
02	**212191-0001		HOUSING-PHOTOCONDUCTOR	EA	0001	00000.000
02	**232618-0020		PHOTOCELL CADMIUM SULFO-SELENIDE TO-5	EA	0002	00002.000
02	**235022-0004		SCREW 4-40 X 3/16 RH	EA	0003	00001.000
02	**235254-0000		SLEEVING TEFLON #24	FT	0004	00000.200
02	**198624-0001	B	HOUSING PHOTOCONDUCTOR	EA	0005	00001.000
03	***236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00000.900
02	**198624-0001	B	MAY BE USED FOR ITEM 1	EA	0005A	.
03	***236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00000.900
01	*212180-0001	*	R7 R8	EA	0010A	.
02	**212191-0001		HOUSING-PHOTOCONDUCTOR	EA	0001	00000.000
02	**232618-0020		PHOTOCELL CADMIUM SULFO-SELENIDE TO-5	EA	0002	00002.000
02	**235022-0004		SCREW 4-40 X 3/16 RH	EA	0003	00001.000
02	**235254-0000		SLEEVING TEFLON #24	FT	0004	00000.200
02	**198624-0001	B	HOUSING PHOTOCONDUCTOR	EA	0005	00001.000
03	***236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00000.900
02	**198624-0001	B	MAY BE USED FOR ITEM 1	EA	0005A	.
03	***236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00000.900
01	*232286-0000		LAMP NEON NE-2U	EA	0012	00002.000
01	* -		DS1 DS2		0012A	.
01	*230692-5000		CAP 1.0000 MF 200V +OR-5%	EA	0014	00003.000
01	* -		C3,C4,C5		0014A	.
01	*230620-0003		CAP .1000 MF 200V +OR-10%	EA	0015	00001.000
01	* -		C6		0015A	.
01	*230814-9000		CAP 25.00 MF 35V	EA	0016	00006.000
01	* -		C7 C10 C17 C18 C23 C24		0016A	.
01	*230425-0000		CAP 130.0 PF 500V 05	EA	0017	00001.000
01	* -		C11		0017A	.
01	*230459-0001		CAP 470.0 PF 1000V 10	EA	0018	00001.000
01	* -		C12		0018A	.
01	*230383-0002		CAP 24.00 PF 500V 05	EA	0019	00001.000
01	* -		C13		0019A	.
01	*230786-0010		CAP 12.0000 MF 30V	EA	0020	00001.000
01	* -		C14		0020A	.
01	*230606-0010		CAP .0680 MF 200V +OR-10%	EA	0021	00002.000

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ASSY LEV	-PART NUMBER---------	REV LTR	DESCRIPTION.....	UM	PRINT ITEM	QUANTITY PER
01	* -		C15 C16		0021A	.
01	*230546-0000		CAP .01000 MF 100V 05%	EA	0022	00002.000
01	* -		C19,C1		0022A	.
01	*230916-2050		CAP 200.00 MF 25V	EA	0023	00003.000
01	* -		C20 C21 C22		0023A	.
01	*173375-0003	H	CAPACITOR- 75 MF 30V NON-POLARIZED	EA	0024	00001.000
01	* -		C25		0024A	.
01	*230658-0001		CAP .4700 MF 35V 10% CASE SIZE-A	EA	0025	00001.000
01	* -		C9		0025A	.
01	*231702-0000		DIODE IN914	EA	0028	00004.000
01	* -		CR1 CR3 CR16 CR17		0028A	.
01	*231692-0001		DIODE VOLTAGE REGULATING 5.6V 5%	EA	0029	00001.000
01	* -		CR2		0029A	.
01	*231678-0000		DIODE IN645	EA	0030	00009.000
01	* -		CR4 THRU CR9 CR13 CR14 CR15		0030A	.
01	*231699-0001		DIODE IN759A	EA	0031	00002.000
01	* -		CR10 CR11		0031A	.
01	*231694-0001		DIODE VOLTAGE REGULATING 6.8V 5%	EA	0032	00001.000
01	* -		CR12		0032A	.
01	*231767-0000		DIODE IN4383	EA	0033	00002.000
01	* -		CR18 CR19		0033A	.
01	*231771-0000		DIODE G4224 ZENIER	EA	0034	00001.000
01	* -		CR20		0034A	.
01	*212177-0001	A	NETWORK-SN-4567N SELECTED SN-72709N	EA	0036	00001.000
01	* -		Z1		0036A	.
01	*234514-0000		RES 150000. OHM .5 W 5.	EA	0038	00001.000
01	* -		R1		0038A	.
01	*233742-0000		RES 910.00 OHM .5 W 5.	EA	0039	00001.000
01	* -		R12		0039A	.
01	*234272-0000		RES 20000. OHM .5 W 5.	EA	0040	00002.000
01	* -		R9 R18		0040A	.
01	*234049-0000		RES 5100.0 OHM .5 W 5.	EA	0041	00001.000
01	* -		R10		0041A	.
01	*233875-0000		RES 2000.0 OHM .5 W 5.	EA	0042	00005.000
01	* -		R37,R39,R52,R53,R11		0042A	.
01	*234282-0000		RES 22000. OHM .5 W 5.	EA	0044	00001.000
01	* -		R13		0044A	.
01	*234414-0000		RES 68000. OHM .5 W 5.	EA	0045	00002.000
01	* -		R15 R49		0045A	.
01	*234158-0000		RES 10000. OHM .5 W 5.	EA	0046	00005.000
01	* -		R16,R17,R3,R4,R5		0046A	.
01	*234732-0000		RES 6.8000 M-OHM .5 W 5.	EA	0047	00001.000
01	* -		R19		0047A	.
01	*233824-0000		RES 1500.0 OHM .5 W 5.	EA	0048	00008.000
01	* -		R20 R44 R45 R55 R56 R41 R42		0048A	.
01	* -		R59		0048B	.
01	*233948-0000		RES 3000.0 OHM .5 W 5.	EA	0049	00002.000
01	* -		R21 R61		0049A	.
01	*234559-1000		RES 250000. OHM .15W .1%	EA	0050	00001.000
01	* -		R22		0050A	.
01	*184848-0001	*	RES-VAR.50 K 30%	EA	0051	00001.000
01	* -		R23		0051A	.
01	*233303-0005		RES 25.1000 OHM 3.W 1.%	EA	0052	00002.000

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ASSY LEV	PART NUMBER	REV LTR		DESCRIPTION	UM	PRINT ITEM	QUANTITY PER
01	* -			R24 R25		0052A	.
01	*184858-0001		*	POTENTIOMETER-100 OHM	EA	0053	00001.000
01	* -			R28		0053A	.
01	*233670-0010			RES 510.0000 OHM 3.W 1.%	EA	0054	00001.000
01	* -			R29		0054A	.
01	*236167-0001			RES VAR. 2K OHM 3067S-1-202	EA	0055	00001.000
01	* -			R30		0055A	.
01	*233799-0010			RES 1250.0000 OHM 1.W 1.%	EA	0056	00001.000
01	* -			R31		0056A	.
01	*233695-0100			RES 650.0000 OHM 1.W 1.%	EA	0057	00001.000
01	* -			R32		0057A	.
01	*233861-8025			RES 1950.0000 OHM 1.W 1.%	EA	0058	00001.000
01	* -			R33		0058A	.
01	*233624-0020			RES 400.0000 OHM 1.W 1.%	EA	0059	00001.000
01	* -			R34		0059A	.
01	*234007-0000			RES 4300.0 OHM .5 W 5.	EA	0060	00001.000
01	* -			R35		0060A	.
01	*233760-0000			RES 1000.0 OHM .5 W 5.	EA	0061	00001.000
01	* -			R36		0061A	.
01	*234138-0000			RES 9100.0 OHM .5 W 5.	EA	0062	00001.000
01	* -			R38		0062A	.
01	*233668-0000			RES 510.00 OHM .5 W 5.	EA	0063	00001.000
01	* -			R40		0063A	.
01	*233651-0000			RES 470.00 OHM .5 W 5.	EA	0064	00001.000
01	* -			R43		0064A	.
01	*234755-0000			RES 22.000 M-OHM .5 W 5.	EA	0065	00001.000
01	* -			R46		0065A	.
01	*232841-0500			RES VAR. 47K E086-8C	EA	0066	00001.000
01	* -			R47		0066A	.
01	*212166-0001			RES.VAR 5K 10%	EA	0067	00001.000
01	* -			R48		0067A	.
01	*233442-0000			RES 100.00 OHM .5 W 5.	EA	0068	00002.000
01	* -			R50 R51		0068A	.
01	*233838-0000			RES 1600.0 OHM .5 W 5.	EA	0069	00001.000
01	* -			R58		0069A	.
01	*234198-0000			RES 12000. OHM .5 W 5.	EA	0070	00001.000
01	* -			R60		0070A	.
01	*199517-0001		E	TRANSISTOR-SELECTED	EA	0072	00001.000
02	**236091-0170			XST SX4058	EA	0001	00001.000
01	*199517-0001		E	Q1	EA	0072A	.
02	**236091-0170			XST SX4058	EA	0001	00001.000
01	*235997-0000			XST 2N697	EA	0073	00001.000
01	* -			Q2		0073A	.
01	*236091-0007			XST SX3707	EA	0074	00003.000
01	* -			Q3 Q4 Q5		0074A	.
01	*236091-0002			XST SX3702	EA	0075	00004.000
01	* -			Q6 Q7 Q8 Q12		0075A	.
01	*236091-0003			XST SX3704	EA	0076	00001.000
01	* -			Q13		0076A	.
01	*212176-0001		A	TRANSFORMER-	EA	0078	00001.000
01	* -			T1		0078A	.
01	*232067-0002			HEATSINK FOR TO-5 NF-207	EA	0079	00001.000
01	*232067-0100			HEATSINK THERMAL RETAINER W/O SHLD TAB	EA	0080	00001.000

212165-0001 B SERVO AMP ASSY-

ASSY LEV	-PART NUMBER----------	REV LTR	DESCRIPTION.....	UM	PRINT ITEM	QUANTITY PER
01	*235278-3000		SOCKET 14 PIN DUAL/INLINE GLD/PLTD CONT	EA	0082	00001.000
01	*235379-0000		SPACER XISTER A-10095	EA	0083	00001.000
01	*231828-0100		EYELET .047 ODX.125 LG BRASS	EA	0086	00004.000
01	*232447-0000		NUT 2-56X3/16X1/16THK SS	EA	0089	00002.000
01	*232456-0000		NUT 6-32X1/4X3/32 THK SST	EA	0090	00004.000
01	*235006-0001		SCREW 2-56X3/8 BH SS	EA	0092	00002.000
01	*235023-0001		SCREW 4-40X1/4 BH SST	EA	0093	00003.000
01	*235053-0001		SCREW 6-32X5/16 BH SST	EA	0094	00002.000
01	*235101-0001		SCREW 10-32 X 3/8 BH	EA	0095	00002.000
01	*235537-0000		STUD FLUSH HD SELF CLINCHING 1/2LG STL	EA	0096	00004.000
01	*236369-0000		WASHER #2 INT.TH . SS	EA	0098	00002.000
01	*236374-0000		WASHER #4 EXT TH SST	EA	0100	00003.000
01	*236385-0000		WASHER #6 FLT SS 1/32 THK	EA	0101	00004.000
01	*236386-0000		WASHER #6 EXT TOOTH LOCK SST	EA	0102	00006.000
01	*236402-0000		WASHER #10 EXT TOOTH LOCK SST	EA	0103	00002.000
01	*236607-0000		WIRE 22 AWG BUS TINNED COPPER SOLID BARE	FT	0107	00000.050
01	*236533-0000		WIRE 24 AWG 1 COND WHITE TEFLON SOLID	FT	0108	00000.750
01	*231024-0600		CEMENT EC-1099	TU	0110	AR.
01	*231995-0004		GREASE SILICONE	EA	0111	AR.
01	*175385-0001	A	PLATE-SERIAL NO	EA	0115	00001.000
01	*212181-9901	A	DIAGRAM-SCHEMATIC MODEL 81 AMPLIFIER	EA	0116	00001.000
01	*212182-9901		TEST SPECS-UNIT	EA	0117	00001.000
01	*230908-0001		CAP 150.0 MF 15V	EA	0119	00001.000
01	* -		C8		0119A	.
01	*230610-0000		CAP .1000 MF 10V +80/-20	EA	0120	00001.000
01	* -		C27		0120A	.

220918-0001 C SERVO AMPLIFIER ASSY INTER SENS MOD B2

ASSY LEV	-PART NUMBER----------	REV LTR	DESCRIPTION.....	UM	PRINT ITEM	QUANTITY PER
01	*211714-0002	B	BOARD-	EA	0001	00001.000
01	*220922-0001		COVER-	EA	0002	00001.000
02	**237461-0001		STL. SHT. .0359 20 GA. COLD RO	SF	0001	00000.600
01	*212167-0001	A	COVER-GROUND	EA	0003	00001.000
02	**237461-0001		STL. SHT. .0359 20 GA. COLD RO	SF	0001	00000.150
01	*212169-0001	*	PLATE-GUARD	EA	0004	00001.000
02	**237461-0001		STL. SHT. .0359 20 GA. COLD RO	SF	0001	00000.250
01	*212170-0001	*	STANDOFF-COVER	EA	0005	00002.000
02	**236820-0000		AL.ROD 3/8 2011-T3	IN	0001	00001.500
01	*212171-0001		RETAINER-AMPLIFIER	EA	0006	00004.000
02	**236869-0000		AL.HX ROD 1/4 2024-T4	IN	0001	00001.625
01	*184824-0001	E	HOUSING-LAMP	EA	0008	00001.000
02	**236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00017.283
01	*184836-0002	G	ROD LIGHT	EA	0009	00002.000
01	*212180-0001	*	HOUSING ASSY,PHOTOCONDUCTOR	EA	0010	00001.000
02	**212191-0001		HOUSING-PHOTOCONDUCTOR	EA	0001	00000.000
02	**232618-0020		PHOTOCELL CADMIUM SULFO-SELENIDE TO-5	EA	0002	00002.000
02	**235022-0004		SCREW 4-40 X 3/16 RH	EA	0003	00001.000
02	**235254-0000		SLEEVING TEFLON #24	FT	0004	00000.200
02	**198624-0001	B	HOUSING PHOTOCONDUCTOR	EA	0005	00001.000
03	***236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00000.900
02	**198624-0001	B	MAY BE USED FOR ITEM 1	EA	0005A	.
03	***236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00000.900
01	*212180-0001	*	R7 R8 (REF)	EA	0010A	.
02	**212191-0001		HOUSING-PHOTOCONDUCTOR	EA	0001	00000.000
02	**232618-0020		PHOTOCELL CADMIUM SULFO-SELENIDE TO-5	EA	0002	00002.000
02	**235022-0004		SCREW 4-40 X 3/16 RH	EA	0003	00001.000
02	**235254-0000		SLEEVING TEFLON #24	FT	0004	00000.200
02	**198624-0001	B	HOUSING PHOTOCONDUCTOR	EA	0005	00001.000
03	***236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00000.900
02	**198624-0001	B	MAY BE USED FOR ITEM 1	EA	0005A	.
03	***236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00000.900
01	*232286-0000		LAMP NEON NE-2U	EA	0012	00002.000
01	* -		DS1 DS2		0012A	.
01	*230558-0003		CAP .01500 MF 200V 05	EA	0013	00001.000
01	* -		C1		0013A	.
01	*230710-0010		CAP 2.0000 MF 200V +OR-5%	EA	0014	00001.000
01	* -		C3		0014A	.
01	*230692-5000		CAP 1.0000 MF 200V +OR-5%	EA	0015	00001.000
01	* -		C4		0015A	.
01	*230661-0004		CAP .4700 MF 200V + OR -5%	EA	0016	00002.000
01	* -		C5 C6		0016A	.
01	*230834-0000		CAP 47.000 MF 6V 10% CASE SIZE B	EA	0017	00001.000
01	* -		C7		0017A	.
01	*230916-2050		CAP 200.00 MF 25V	EA	0018	00004.000
01	* -		C8 C20 C21 C22		0018A	.
01	*230658-0001		CAP .4700 MF 35V 10% CASE SIZE-A	EA	0019	00001.000
01	* -		C9		0019A	.
01	*230814-9000		CAP 25.00 MF 35V	EA	0020	00005.000
01	* -		C10 C17 C18 C23 C24		0020A	.
01	*230425-0000		CAP 130.0 PF 500V 05	EA	0021	00001.000
01	* -		C11		0021A	.
01	*230459-0001		CAP 470.0 PF 1000V 10	EA	0022	00001.000

220918-0001 C SERVO AMPLIFIER ASSY INTER SENS MOD B2

ASSY LEV	PART NUMBER	REV LTR	DESCRIPTION	UM	PRINT ITEM	QUANTITY PER
01	* -		C12		0022A	.
01	*230383-0002		CAP 24.00 PF 500V 05	EA	0023	00001.000
01	* -		C13		0023A	.
01	*230786-0010		CAP 12.0000 MF 30V	EA	0024	00001.000
01	* -		C14		0024A	.
01	*230587-0100		CAP .04700 MF 200V + OR -5%	EA	0025	00001.000
01	* -		C15		0025A	.
01	*230606-0010		CAP .0680 MF 200V +OR-10%	EA	0026	00001.000
01	* -		C16		0026A	.
01	*230546-0000		CAP .01000 MF 100V 05%	EA	0027	00001.000
01	* -		C19		0027A	.
01	*173375-0003	H	CAPACITOR- 75 MF 30V NON-POLARIZED	EA	0028	00001.000
01	* -		C25		0028A	.
01	*230610-0000		CAP .1000 MF 10V 80%-20	EA	0029	00001.000
01	* -		C27		0029A	.
01	*231692-0001		DIODE VOLTAGE REGULATING 5.6V 5%	EA	0031	00001.000
01	* -		CR2		0031A	.
01	*231702-0000		DIODE IN914	EA	0032	00003.000
01	* -		CR3 CR16 CR17		0032A	.
01	*231678-0000		DIODE IN645	EA	0033	00009.000
01	* -		CR4 THRU CR9 CR13 CR14 CR15		0033A	.
01	*231699-0001		DIODE IN759A	EA	0034	00002.000
01	* -		CR10 CR11		0034A	.
01	*231694-0001		DIODE VOLTAGE REGULATING 6.8V 5%	EA	0035	00001.000
01	* -		CR12		0035A	.
01	*231767-0000		DIODE IN4383	EA	0036	00002.000
01	* -		CR18 CR19		0036A	.
01	*231771-0000		DIODE G4224 ZENIER	EA	0037	00001.000
01	* -		CR20		0037A	.
01	*212177-0001	A	NETWORK-SN-4567N SELECTED SN-72709N	EA	0040	00001.000
01	* -		Z1		0040A	.
01	*234474-0001		RES 100000.00 OHM .25W 1.%	EA	0043	00001.000
01	* -		R1		0043A	.
01	*233972-3653		RES 3650.0000 OHM .25W 1.%	EA	0044	00001.000
01	* -		R3		0044A	.
01	*234104-7503		RES 7500.0000 OHM .25W 1.%	EA	0045	00001.000
01	* -		R4		0045A	.
01	*234225-0002		RES 15000. OHM .25W 1.	EA	0046	00001.000
01	* -		R5		0046A	.
01	*234414-0000		RES 68000. OHM .5 W 5.	EA	0047	00003.000
01	* -		R9 R15 R49		0047A	.
01	*233620-0000		RES 390.00 OHM .25W 5.	EA	0048	00001.000
01	* -		R10		0048A	.
01	*234078-0000		RES 6200.0 OHM .5 W 5.	EA	0049	00001.000
01	* -		R11		0049A	.
01	*234312-9000		RES 30000. OHM .125W 1.%	EA	0050	00001.000
01	* -		R12		0050A	.
01	*234496-0050		RES 120000. OHM .125W 1.%	EA	0051	00001.000
01	* -		R13		0051A	.
01	*234158-0000		RES 10000. OHM .5 W 5.	EA	0052	00002.000
01	* -		R16 R17		0052A	.
01	*234272-0000		RES 20000. OHM .5 W 5.	EA	0053	00001.000
01	* -		R18		0053A	.

220918-0001 C SERVO AMPLIFIER ASSY INTER SENS MOD B2

ASSY LEV	-PART NUMBER----------	REV LTR	DESCRIPTION.....	UM	PRINT ITEM	QUANTITY PER
01	*234732-0000		RES 6.8000 M-OHM .5 W 5.	EA	0054	00001.000
01	* -		R19		0054A	.
01	*233824-0000		RES 1500.0 OHM .5 W 5.	EA	0055	00008.000
01	* -		R20 R44 R45 R55 R56 R41 R42		0055A	.
01	* -		R59		0055B	.
01	*233948-0000		RES 3000.0 OHM .5 W 5.	EA	0056	00002.000
01	* -		R21 R61		0056A	.
01	*234559-1000		RES 250000. OHM .15W .1%	EA	0057	00001.000
01	* -		R22		0057A	.
01	*184848-0001	*	RES-VAR.50 K 30%	EA	0058	00001.000
01	* -		R23		0058A	.
01	*233303-0005		RES 25.1000 OHM 3.W 1.%	EA	0059	00002.000
01	* -		R24 R25		0059A	.
01	*184858-0001	*	POTENTIOMETER-100 OHM	EA	0060	00001.000
01	* -		R28		0060A	.
01	*233624-0003		RES 400.00 OHM 3. W 1.	EA	0061	00001.000
01	* -		R29		0061A	.
01	*236148-0005		RES VAR 500 OHM .6W + OR . 5.%%	EA	0062	00001.000
01	* -		R30		0062A	.
01	*233624-0020		RES 400.0000 OHM 1.W 1.%	EA	0063	00002.000
01	* -		R32 R34		0063A	.
01	*233861-8025		RES 1950.0000 OHM 1.W 1.%	EA	0064	00001.000
01	* -		R33		0064A	.
01	*234007-0000		RES 4300.0 OHM .5 W 5.	EA	0065	00001.000
01	* -		R35		0065A	.
01	*233760-0000		RES 1000.0 OHM .5 W 5.	EA	0066	00001.000
01	* -		R36		0066A	.
01	*233875-0000		RES 2000.0 OHM .5 W 5.	EA	0067	00004.000
01	* -		R37 R39 R52 R53		0067A	.
01	*234138-0000		RES 9100.0 OHM .5 W 5.	EA	0068	00001.000
01	* -		R38		0068A	.
01	*233222-0010		RES 10.000 OHM .5 W 5.	EA	0069	00002.000
01	* -		R40,R43		0069A	.
01	*234755-0000		RES 22.000 M-OHM .5 W 5.	EA	0071	00001.000
01	* -		R46		0071A	.
01	*232841-0500		RES VAR. 47K E086-BC	EA	0072	00001.000
01	* -		R47		0072A	.
01	*212166-0001		RES.VAR 5K 10%	EA	0073	00001.000
01	* -		R48		0073A	.
01	*233532-0000		RES 200.00 OHM .5 W 5.	EA	0074	00002.000
01	* -		R50,R51		0074A	.
01	*233838-0000		RES 1600.0 OHM .5 W 5.	EA	0075	00001.000
01	* -		R58		0075A	.
01	*234198-0000		RES 12000. OHM .5 W 5.	EA	0076	00001.000
01	* -		R60		0076A	.
01	*234354-0000		RES 43000. OHM .25W 5.	EA	0077	00001.000
01	* -		R64		0077A	.
01	*233530-0000		RES 200.00 OHM .25W 5.	EA	0078	00001.000
01	* -		R31		0078A	.
01	*199517-0001	E	TRANSISTOR-SELECTED	EA	0080	00001.000
02	**236091-0170		XST SX4058	EA	0001	00001.000
01	*199517-0001	E	Q1	EA	0080A	.
02	**236091-0170		XST SX4058	EA	0001	00001.000

220918-0001 C SERVO AMPLIFIER ASSY INTER SENS MOD B2

ASSY LEV	PART NUMBER	REV LTR	DESCRIPTION	UM	PRINT ITEM	QUANTITY PER
01	*235997-0000		XST 2N697	EA	0081	00001.000
01	* -		Q2		0081A	.
01	*236091-0007		XST SX3707	EA	0082	00003.000
01	* -		Q3 Q4 Q5		0082A	.
01	*236091-0002		XST SX3702	EA	0083	00004.000
01	* -		Q6 Q7 Q8 Q12		0083A	.
01	*236091-0003		XST SX3704	EA	0084	00001.000
01	* -		Q13		0084A	.
01	*212176-0001	A	TRANSFORMER-	EA	0087	00001.000
01	* -		T1		0087A	.
01	*232067-0003		HEATSINK NF-209	EA	0090	00001.000
01	*232067-0100		HEATSINK THERMAL RETAINER W/O SHLD TAB	EA	0091	00001.000
01	*235278-3000		SOCKET 14 PIN DUAL/INLINE GLD/PLTD CONT	EA	0092	00001.000
01	*235379-0000		SPACER XISTER A-10095	EA	0093	00002.000
01	*231828-0100		EYELET .047 ODX.125 LG BRASS	EA	0094	00004.000
01	*232456-0000		NUT 6-32X1/4X3/32 THK SST	EA	0096	00004.000
01	*235023-0001		SCREW 4-40X1/4 BH SST	EA	0098	00002.000
01	*235053-0001		SCREW 6-32X5/16 BH SST	EA	0099	00002.000
01	*235101-0001		SCREW 10-32 X 3/8 BH	EA	0100	00002.000
01	*235537-0000		STUD FLUSH HD SELF CLINCHING 1/2LG STL	EA	0101	00004.000
01	*236374-0000		WASHER #4 EXT TH SST	EA	0103	00002.000
01	*236385-0000		WASHER #6 FLT SS 1/32 THK	EA	0104	00004.000
01	*236386-0000		WASHER #6 EXT TOOTH LOCK SST	EA	0105	00006.000
01	*236402-0000		WASHER #10 EXT TOOTH LOCK SST	EA	0106	00002.000
01	*236533-0000		WIRE 24 AWG 1 COND WHITE TEFLON SOLID	FT	0108	00000.750
01	*236319-0000		TUBING 3/8 .375 ID BLK.PLAS	FT	0109	00000.042
01	*231024-0600		CEMENT EC-1099	TU	0110	AR.
01	*231995-0004		GREASE SILICONE	EA	0111	AR.
01	*236342-2000		VARNISH 277	CN	0112	AR.
01	*175385-0001	A	PLATE-SERIAL NO	EA	0115	00001.000
01	*220919-9901	A	DIAGRAM-SCHEMATIC MODEL B2 AMPLIFIER	EA	0116	00001.000
01	*220926-9901		TEST SPECS-UNIT-INTER SENS MOD B2	EA	0117	00001.000

212183-0001 * CABLE ASSY-AMPLIFIER

ASSY LEV	-PART NUMBER----------	REV LTR	DESCRIPTION.....	UM	PRINT ITEM	QUANTITY PER
01	*231253-1110		CONNECTOR 480110-2	EA	0001	00001.000
01	* -		P3		0001A	.
01	*231253-0084		CONNECTOR 6P WHT CAP 480084-1	EA	0002	00001.000
01	* -		P2		0002A	.
01	*231253-2122		CONNECTOR 6P RED CAP 480122-2	EA	0003	00001.000
01	* -		P4		0003A	.
01	*231253-6122		CONNECTOR 6P BLU CAP 480122-6	EA	0004	00001.000
01	* -		P6		0004A	.
01	*231553-0010		CONTACT LEAF 42717-3	EA	0005	00018.000
01	*232142-0003		INSERT CONNECTOR 42859-1	EA	0006	00018.000
01	*235411-0100		SPRING COMMONING 66092-1	EA	0007	00006.000
01	*235463-0001		STRAP MINATURE BUNDLE DIA 0 TO 3/4 IN	EA	0008	00003.000
01	*236317-0000		TUBING #4 .208 ID BLK. PLASTIC HYFLEX	EA	0009	00002.000
01	*236524-0003		WIRE 22 AWG 1 COND ORANGE PVC STRD	FT	0010	00002.500
01	*236524-0001		WIRE 22 AWG 1 COND BROWN PVC STRD	FT	0011	00002.500
01	*236524-0002		WIRE 22 AWG 1 COND RED PVC STRD	FT	0012	00002.500
01	*236524-0005		WIRE 22 AWG 1 COND GREEN PVC STRD	FT	0013	00002.500
01	*236524-0006		WIRE 22 AWG 1 COND BLUE PVC STRD	FT	0014	00001.300
01	*236524-0009		WIRE 22 AWG 1 COND WHITE PVC STRD	FT	0015	00001.100
01	*236524-0004		WIRE 22 AWG 1 COND YELLOW PVC STRD	FT	0016	00001.400
01	*236524-0008		WIRE 22 AWG 1 COND GRAY PVC STRD	FT	0017	00001.200

212175-0001 A POWER SUPPLY ASSY

ASSY LEV	-PART NUMBER---------	REV LTR	DESCRIPTION.....	UM	PRINT ITEM	QUANTITY PER
01	*212174-0001	A	TRANSFORMER-POWER	EA	0001	00001.000
01	* -		T2		0001A	.
01	*212172-0001		BRACKET-CONNECTOR	EA	0002	00001.000
02	**236909-0000		AL.SHT. .063 5052-H34	SF	0001	00000.100
01	*231253-0083		CONNECTOR 6P WHT PLUG 480083-1	EA	0003	00001.000
01	* -		J2		0003A	.
01	*231253-0084		CONNECTOR 6P WHT CAP 480084-1	EA	0004	00001.000
01	* -		J1		0004A	.
01	*232142-0003		INSERT CONNECTOR 42859-1	EA	0005	00009.000
01	*232361-0002		LUG #6 SPADE 41588	EA	0006	00001.000
01	*197010-0037		CAPACITOR-1.5 MF 400V	EA	0007	00001.000
01	* -		C26		0007A	.
01	*236524-0005		WIRE 22 AWG 1 COND GREEN PVC STRD	FT	0008	00000.800
01	*232916-0100		RECEPTACLE 60804-1	EA	0009	00006.000
01	*236304-0004		TUBING #20 YEL PVC105/20	FT	0010	00000.500
01	*236270-0300		TUBING 10CLR ALPHA PVC-105	FT	0011	00000.042
01	*232533-0001		NUT SPEED C7852-6Z-S-24	EA	0012	00004.000
01	*235463-0001		STRAP MINATURE BUNDLE DIA 0 TO 3/4 IN	EA	0013	00007.000
01	*235463-0002		STRAP STANDARD BUNDLE DIA 0 TO 1-3/4 IN	EA	0014	00001.000
01	*236310-0000		TUBING #12 .085 ID CLR.PLAS	FT	0015	00000.300

212198-0001 * SERVO AMPLIFIER ASSY INTER SENS MOD B3

ASSY LEV	-PART NUMBER----------	REV LTR	DESCRIPTION.....	UM	PRINT ITEM	QUANTITY PER
01	*211709-0001	*	BOARD AMP INTER SENS MODEL B3	EA	0001	00001.000
02	**211709-0002	*	BOARD AMP INTER SENS MODEL B3	EA	0004	00001.000
03	***156401-1062	C	PLASTIC SHT.062 LAM CO-CLAD 1S EPOXY GLS	SI	0001	00068.000
03	***211709-9901		ARTWORK PC	EA	0002	00001.000
03	***211709-9801		ARTWORK SILKSCREEN	EA	0003	00001.000
02	**232671-1125		PIN FORMED .058 DIA GOLD PLATED	EA	0005	00038.000
02	**235320-0100		SOCKET SPRING .030-.033 PIN	EA	0006	00016.000
02	**235319-9000		SOCKET SPRING .018 TO .021 PIN DIA GOLD	EA	0007	00002.000
02	**232168-0005		JACK FOR .025 DIA LEAD .140LG GOLD PLT	EA	0008	00008.000
01	*220922-0001		COVER-	EA	0002	00001.000
02	**237461-0001		STL. SHT. .0359 20 GA. COLD RO	SF	0001	00000.600
01	*212167-0001	A	COVER-GROUND	EA	0003	00001.000
02	**237461-0001		STL. SHT. .0359 20 GA. COLD RO	SF	0001	00000.150
01	*212169-0001	*	PLATE-GUARD	EA	0004	00001.000
02	**237461-0001		STL. SHT. .0359 20 GA. COLD RO	SF	0001	00000.250
01	*212170-0001	*	STANDOFF-COVER	EA	0005	00002.000
02	**236820-0000		AL.ROD 3/8 2011-T3	IN	0001	00001.500
01	*212171-0001		RETAINER-AMPLIFIER	EA	0006	00004.000
02	**236869-0000		AL.HX ROD 1/4 2024-T4	IN	0001	00001.625
01	*184824-0001	E	HOUSING-LAMP	EA	0008	00001.000
02	**236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00017.283
01	*184836-0002	G	ROD LIGHT	EA	0009	00002.000
01	*212180-0001	*	HOUSING ASSY,PHOTOCONDUCTOR	EA	0010	00001.000
02	**212191-0001		HOUSING-PHOTOCONDUCTOR	EA	0001	00000.000
02	**232618-0020		PHOTOCELL CADMIUM SULFO-SELENIDE TO-5	EA	0002	00002.000
02	**235022-0004		SCREW 4-40 X 3/16 RH	EA	0003	00001.000
02	**235254-0000		SLEEVING TEFLON #24	FT	0004	00000.200
02	**198624-0001	B	HOUSING PHOTOCONDUCTOR	EA	0005	00001.000
03	***236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00000.900
02	**198624-0001	B	MAY BE USED FOR ITEM 1	EA	0005A	.
03	***236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00000.900
01	*212180-0001	*	R7 R8 (REF)	EA	0010A	.
02	**212191-0001		HOUSING-PHOTOCONDUCTOR	EA	0001	00000.000
02	**232618-0020		PHOTOCELL CADMIUM SULFO-SELENIDE TO-5	EA	0002	00002.000
02	**235022-0004		SCREW 4-40 X 3/16 RH	EA	0003	00001.000
02	**235254-0000		SLEEVING TEFLON #24	FT	0004	00000.200
02	**198624-0001	B	HOUSING PHOTOCONDUCTOR	EA	0005	00001.000
03	***236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00000.900
02	**198624-0001	B	MAY BE USED FOR ITEM 1	EA	0005A	.
03	***236732-0000		AL.BAR 3/8X3/4 2024-T4	IN	0001	00000.900
01	*232286-0000		LAMP NEON NE-2U	EA	0012	00002.000
01	* -		DS1 DS2		0012A	.
01	*230558-0003		CAP .01500 MF 200V 05	EA	0013	00001.000
01	* -		C1		0013A	.
01	*230710-0010		CAP 2.0000 MF 200V +OR-5%	EA	0014	00001.000
01	* -		C3		0014A	.
01	*230692-5000		CAP 1.0000 MF 200V +OR-5%	EA	0015	00001.000
01	* -		C4		0015A	.
01	*230661-0004		CAP .4700 MF 200V + OR -5%	EA	0016	00002.000
01	* -		C5 C6		0016A	.
01	*230834-0000		CAP 47.000 MF 6V 10% CASE SIZE B	EA	0017	00001.000
01	* -		C7		0017A	.
01	*230916-2050		CAP 200.00 MF 25V	EA	0018	00004.000

212198-0001 * SERVO AMPLIFIER ASSY INTER SENS MOD B3

ASSY LEV	PART NUMBER	REV LTR	DESCRIPTION	UM	PRINT ITEM	QUANTITY PER
01	* -		C8 C20 C21 C22		0018A	.
01	*230658-0001		CAP .4700 MF 35V 10% CASE SIZE-A	EA	0019	00001.000
01	* -		C9		0019A	.
01	*230814-9000		CAP 25.00 MF 35V	EA	0020	00004.000
01	* -		C10 C17 C23 C24		0020A	.
01	*230425-0000		CAP 130.0 PF 500V 05	EA	0021	00001.000
01	* -		C11		0021A	.
01	*230459-0001		CAP 470.0 PF 1000V 10	EA	0022	00001.000
01	* -		C12		0022A	.
01	*230383-0002		CAP 24.00 PF 500V 05	EA	0023	00001.000
01	* -		C13		0023A	.
01	*230786-0010		CAP 12.0000 MF 30V	EA	0024	00001.000
01	* -		C14		0024A	.
01	*230620-0003		CAP .1000 MF 200V +OR-10%	EA	0025	00001.000
01	* -		C15		0025A	.
01	*230606-0010		CAP .0680 MF 200V +OR-10%	EA	0026	00001.000
01	* -		C16		0026A	.
01	*230546-0000		CAP .01000 MF 100V 05%	EA	0027	00001.000
01	* -		C19		0027A	.
01	*173375-0003	H	CAPACITOR- 75 MF 30V NON-POLARIZED	EA	0028	00001.000
01	* -		C25		0028A	.
01	*230610-0000		CAP .1000 MF 10V 80/-20	EA	0029	00001.000
01	* -		C27		0029A	.
01	*230908-0001		CAP 150.0 MF 15V	EA	0030	00001.000
01	* -		C18		0030A	.
01	*231692-0001		DIODE VOLTAGE REGULATING 5.6V 5%	EA	0031	00001.000
01	* -		CR2		0031A	.
01	*231702-0000		DIODE IN914	EA	0032	00003.000
01	* -		CR3 CR16 CR17		0032A	.
01	*231678-0000		DIODE IN645	EA	0033	00009.000
01	* -		CR4 THRU CR9 CR13 CR14 CR15		0033A	.
01	*231699-0001		DIODE IN759A	EA	0034	00002.000
01	* -		CR10 CR11		0034A	.
01	*231694-0001		DIODE VOLTAGE REGULATING 6.8V 5%	EA	0035	00001.000
01	* -		CR12		0035A	.
01	*231767-0000		DIODE IN4383	EA	0036	00002.000
01	* -		CR18 CR19		0036A	.
01	*231771-0000		DIODE G4224 ZENIER	EA	0037	00001.000
01	* -		CR20		0037A	.
01	*212177-0001	A	NETWORK-SN-4567N SELECTED SN-72709N	EA	0040	00001.000
01	* -		Z1		0040A	.
01	*234474-0001		RES 100000.00 OHM .25W 1.%	EA	0043	00001.000
01	* -		R1		0043A	.
01	*233972-3653		RES 3650.0000 OHM .25W 1.%	EA	0044	00001.000
01	* -		R3		0044A	.
01	*234104-7503		RES 7500.0000 OHM .25W 1.%	EA	0045	00001.000
01	* -		R4		0045A	.
01	*234225-0002		RES 15000. OHM .25W 1.	EA	0046	00001.000
01	* -		R5		0046A	.
01	*234414-0000		RES 68000. OHM .5 W 5.	EA	0047	00003.000
01	* -		R9 R15 R49		0047A	.
01	*233620-0000		RES 390.00 OHM .25W 5.	EA	0048	00001.000
01	* -		R10		0048A	.

212198-0001 * SERVO AMPLIFIER ASSY INTER SENS MOD B3

ASSY LEV	PART NUMBER	REV LTR		DESCRIPTION	UM	PRINT ITEM	QUANTITY PER
01	*234078-0000			RES 6200.0 OHM .5 W 5.	EA	0049	00001.000
01	* -			R11		0049A	.
01	*234312-9000			RES 30000. OHM .125W 1.%	EA	0050	00001.000
01	* -			R12		0050A	.
01	*234496-0050			RES 120000. OHM .125W 1.%	EA	0051	00001.000
01	* -			R13		0051A	.
01	*234158-0000			RES 10000. OHM .5 W 5.	EA	0052	00003.000
01	* -			R16 R17 R68		0052A	.
01	*234272-0000			RES 20000. OHM .5 W 5.	EA	0053	00001.000
01	* -			R18		0053A	.
01	*234732-0000			RES 6.8000 M-OHM .5 W 5.	EA	0054	00001.000
01	* -			R19		0054A	.
01	*233824-0000			RES 1500.0 OHM .5 W 5.	EA	0055	00008.000
01	* -			R20 R44 R45 R55 R56 R41 R42		0055A	.
01	* -			R59		0055B	.
01	*233948-0000			RES 3000.0 OHM .5 W 5.	EA	0056	00002.000
01	* -			R21 R61		0056A	.
01	*234508-0004			RES 138000. OHM .15W .1%	EA	0057	00001.000
01	* -			R22		0057A	.
01	*184848-0001		*	RES-VAR.50 K 30%	EA	0058	00001.000
01	* -			R23		0058A	.
01	*233419-0000			RES 82.000 OHM .5 W 5.	EA	0059	00001.000
01	* -			R67		0059A	.
01	*232742-0600			RES VAR. 100 OHM .6W+OR-5.% TOP ADJD	EA	0060	00002.000
01	* -			R28 R29		0060A	.
01	*233516-3000			RES 180.0000 OHM .125W 1.%	EA	0061	00002.000
01	* -			R65 R26		0061A	.
01	*236148-0005			RES VAR 500 OHM .6W + OR . 5.%%	EA	0062	00001.000
01	* -			R30		0062A	.
01	*233624-0020			RES 400.0000 OHM 1.W 1.%	EA	0063	00002.000
01	* -			R32 R34		0063A	.
01	*233861-8025			RES 1950.0000 OHM 1.W 1.%	EA	0064	00001.000
01	* -			R33		0064A	.
01	*234007-0000			RES 4300.0 OHM .5 W 5.	EA	0065	00001.000
01	* -			R35		0065A	.
01	*233760-0000			RES 1000.0 OHM .5 W 5.	EA	0066	00001.000
01	* -			R36		0066A	.
01	*233875-0000			RES 2000.0 OHM .5 W 5.	EA	0067	00004.000
01	* -			R37 R39 R52 R53		0067A	.
01	*234138-0000			RES 9100.0 OHM .5 W 5.	EA	0068	00001.000
01	* -			R38		0068A	.
01	*233224-0000			RES 10.000 OHM .5 W 5.	EA	0069	00002.000
01	* -			R40 R43		0069A	.
01	*233530-0000			RES 200.00 OHM .25W 5.	EA	0070	00001.000
01	*233651-0000			R72	EA	0070A	.
01	*234755-0000			RES 22.000 M-OHM .5 W 5.	EA	0071	00001.000
01	* -			R46		0071A	.
01	*232841-0500			RES VAR. 47K E086-BC	EA	0072	00001.000
01	* -			R47		0072A	.
01	*212166-0001			RES.VAR 5K 10%	EA	0073	00001.000
01	* -			R48		0073A	.
01	*233532-0000			RES 200.00 OHM .5 W 5.	EA	0074	00002.000
01	* -			R50 R51		0074A	.

212198-0001 * SERVO AMPLIFIER ASSY INTER SENS MOD B3

ASSY LEV	PART NUMBER	REV LTR	DESCRIPTION	UM	PRINT ITEM	QUANTITY PER
01	*233838-0000		RES 1600.0 OHM .5 W 5.	EA	0075	00001.000
01	* -		R58		0075A	.
01	*234198-0000		RES 12000. OHM .5 W 5.	EA	0076	00001.000
01	* -		R60		0076A	.
01	*233221-0000		RES 10.000 OHM .25W 5.	EA	0078	00001.000
01	* -		R71		0078A	.
01	*199517-0001	E	TRANSISTOR-SELECTED	EA	0080	00001.000
02	**236091-0170		XST SX4058	EA	0001	00001.000
01	*199517-0001	E	Q1	EA	0080A	.
02	**236091-0170		XST SX4058	EA	0001	00001.000
01	*235995-0000		XST 2N656	EA	0081	00001.000
01	* -		Q2		0081A	.
01	*236091-0007		XST SX3707	EA	0082	00003.000
01	* -		Q3 Q4 Q5		0082A	.
01	*236091-0002		XST SX3702	EA	0083	00004.000
01	* -		Q6 Q7 Q8 Q12		0083A	.
01	*236091-0003		XST SX3704	EA	0084	00001.000
01	* -		Q13		0084A	.
01	*212176-0001	A	TRANSFORMER-	EA	0087	00001.000
01	* -		T1		0087A	.
01	*232067-0003		HEATSINK NF-209	EA	0090	00001.000
01	*232067-0100		HEATSINK THERMAL RETAINER W/O SHLD TAB	EA	0091	00001.000
01	*235278-3000		SOCKET 14 PIN DUAL/INLINE GLD/PLTD CONT	EA	0092	00001.000
01	*184262-0001		INSUL-XST NYLON TO-5 CASE RED	EA	0093	00006.000
01	*231828-0100		EYELET .047 ODX.125 LG BRASS	EA	0094	00004.000
01	*235379-0000		SPACER XISTER A-10095	EA	0095	00001.000
01	*232456-0000		NUT 6-32X1/4X3/32 THK SST	EA	0096	00004.000
01	*235023-0001		SCREW 4-40X1/4 BH SST	EA	0098	00002.000
01	*235053-0001		SCREW 6-32X5/16 BH SST	EA	0099	00002.000
01	*235101-0001		SCREW 10-32 X 3/8 BH	EA	0100	00002.000
01	*235537-0000		STUD FLUSH HD SELF CLINCHING 1/2LG STL	EA	0101	00004.000
01	*236374-0000		WASHER #4 EXT TH SST	EA	0103	00002.000
01	*236385-0000		WASHER #6 FLT SS 1/32 THK	EA	0104	00004.000
01	*236386-0000		WASHER #6 EXT TOOTH LOCK SST	EA	0105	00006.000
01	*236402-0000		WASHER #10 EXT TOOTH LOCK SST	EA	0106	00002.000
01	*236533-0000		WIRE 24 AWG 1 COND WHITE TEFLON SOLID	FT	0108	00000.750
01	*236319-0000		TUBING 3/8 .375 ID BLK.PLAS	FT	0109	00000.100
01	*231024-0600		CEMENT EC-1099	TU	0110	AR.
01	*231995-0004		GREASE SILICONE	EA	0111	AR.
01	*236342-2000		VARNISH 277	CN	0112	AR.
01	*175385-0001	A	PLATE-SERIAL NO	EA	0115	00001.000
01	*212199-9901		DIAGRAM-SCHEMATIC	EA	0116	00001.000
01	*212200-9901		TEST SPECS-UNIT	EA	0117	00001.000

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TEXAS INSTRUMENTS
INCORPORATED

P. O. BOX 66027 HOUSTON, TEXAS 77006

August 8, 1968

servo/riter® II RECORDER

PLEASE READ BEFORE PACKING RECORDER FOR SHIPMENT

Drain ink and flush inking system with water. Repackage in original packing. If original packing is not available:

1. Wrap recorder in heavy paper to protect finish.
2. Place recorder in tight fitting corrugated fibre board box.
3. Place this assembly into a second corrugated fibre board box large enough to provide at least 3 inches of resilient cushioning material on all sides of the inner box. The preferable material is rubberized horse hair pads. Excelsior should not be used since it tends to settle, leaving parts of the unit unprotected.

If, for any reason, this instrument must be returned to Texas Instruments for service, please check the below listed items which best describe the nature of your problem. Additional space is provided under "Remarks" for any further information you might wish to add. This information will enable our service department to give the most efficient service.

This completed repair form should be placed inside the unit to be returned, before it is packed for shipment.

MODEL _____ SERIAL NO. _____

- ☐ Servoamplifier
- ☐ Servo, Mechanical
- ☐ Chart Carriage
- ☐ Chart Drive or Transmission
- ☐ Chart Takeup
- ☐ Inking System or Pens
- ☐ Calibration

ACCESSORIES

- ☐ Marker Pens
- ☐ Control Devices
- ☐ Other

REPAIR REQUIREMENTS

- ☐ General Overhaul
- ☐ Repair as Required

REMARKS _____

_____

_____

NAME _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

PHONE: AREA CODE _____ NUMBER _____

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